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VOL. 38 MAI-JUIN 1959 NO. 3

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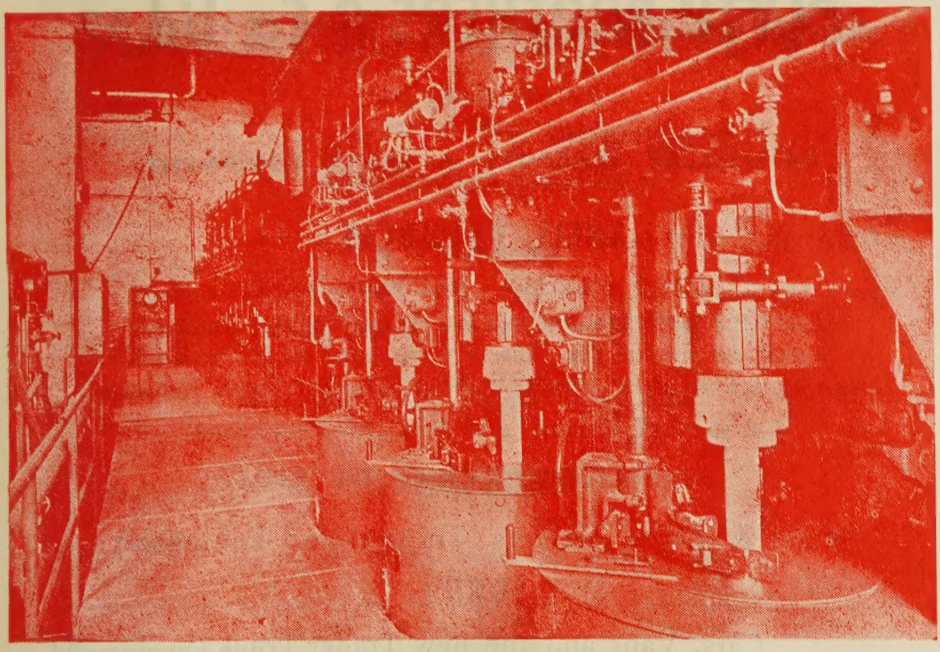

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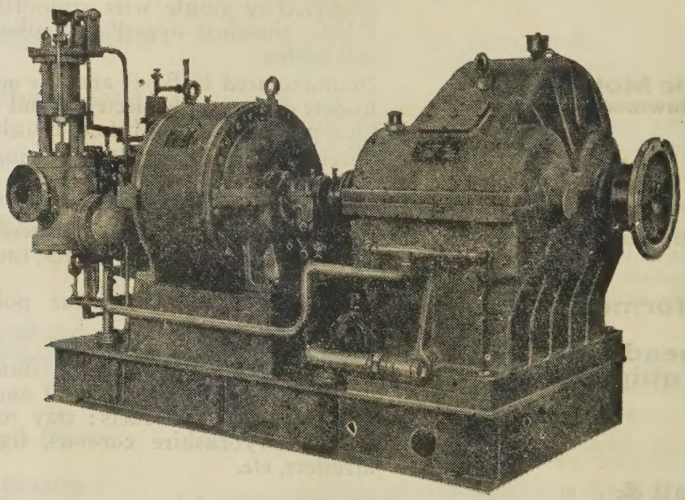

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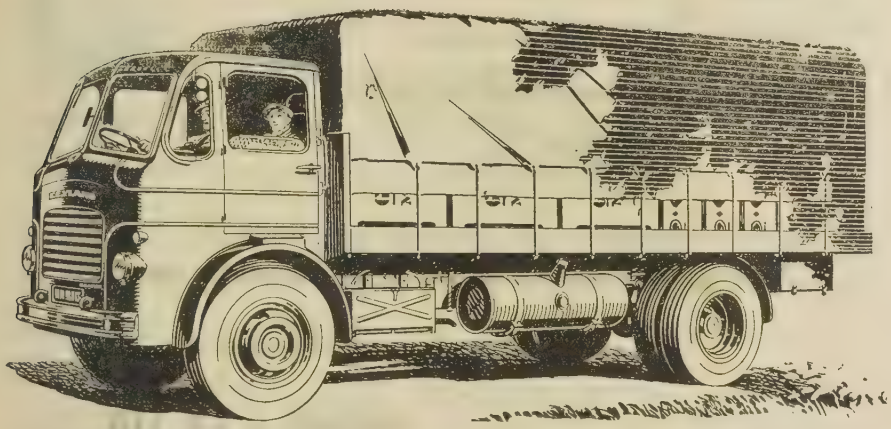

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REVUE AGRICOLE ET SUCRIÈRE DE L'ÎLE MAURICE

VOL. 38 No. 3 . . MAI-JUIN 1959

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1959

NOTES ET ACTUALITÉS

Les travaux de développement au Département de l'Agriculture

La réalisation des projets de développement du Département de l'Agriculture se poursuit au rythme prévu malgré quelques difficultés inévitables de démarrage. Les stations expérimentales dont l'aménagement moderne en bâtiments et équipement commença en 1952, sont maintenant en mesure d'être consacrées presque totalement aux programmes de recherches agricoles. A Richelieu on construit deux sècheries de tabac selon les recommandations de M. Byles, spécialiste du tabac qui visita le pays en 1957. Deux autres sècheries sont prévues pour l'année financière juillet 1959 — juin 1960. La construction d'une sècherie *home made*, édifiée à très bon compte pour le séchage du tabac à l'air, vient d'être terminée. Des vergers sont en cours d'aménagement. Un poulailler à très bon marché, pour l'usage de tout petits éleveurs, a été construit aux fins de démonstration. Au Réduit on a mis au point un projet de production d'œufs et de poussins de races sélectionnées. D'ici un an on pourra s'attendre à obtenir de cet élevage des œufs à mettre à couver ou des poussins d'un jour des races Leghorn, Rhode Island Red et New Hampshire. A Curepipe on a terminé une porcherie destinée à fournir des produits de race dans le but de stimuler l'élevage porcin dans le pays. A la Station horticole de Barkly des dispositions ont été prises pour augmenter la production de semences potagères tant appréciées des maraîchers et des amateurs de jardinage. La station sera agrandie par l'adjonction d'un terrain avoisinant de 11 arpents environ. A Curepipe on a creusé des petits bassins pour la production de Tilapia à l'échelle du paysannat. A Palmar le défoncement des terres rocheuses à l'entour de la ferme d'élevage pour l'acclimatation de nouvelles espèces fourragères, dont les semences ont été commandées de l'extérieur, a commencé. Dans le domaine du retour à la terre, des lotissements supplémentaires ont été créés à Palmar sur la côte est et à Bémanique dans les hauteurs. A Plaisance on envisage l'établissement d'autres lotissements, la création d'un centre de vulgarisation agricole et la plantation intensive de cultures vivrières. A Mapou, un autre centre de vulgarisation a été inauguré le 24 février dernier. Des plans sont mis au point à l'heure actuelle pour la construction d'un abattoir moderne à Port-Louis près du *Fort George*, et d'un entrepôt frigorifique où des denrées alimentaires de toutes sortes, des fruits, de la viande, du poisson, des semences de pomme de terre pourront être conservées. Du côté de l'industrie du thé de nouvelles terres sont en train d'être aménagées pour être louées à des petits planteurs tandis que la nouvelle usine à thé du Gouvernement vient d'être inaugurée par Son Excellence le Gouverneur.

Ne pensons pas à l'émigration

Selon un rapport très documenté de l'UNESCO, la population du globe augmente de 47 millions d'individus par année, soit de 5,400 par heure. A la fin du siècle, elle pourrait bien atteindre le double de son chiffre actuel qui est de

2 milliards 737 millions d'habitants. Dans le monde entier, la durée moyenne de l'existence augmente. Elle est toutefois très différente selon les parties du monde ; ainsi, elle est de 71 ans aux Pays-Bas, alors qu'elle n'atteint que 32 ans en Inde. Il découle de ces chiffres que l'émigration d'un pays à un autre ne peut plus être envisagée comme une solution possible des problèmes de surpopulation puisqu'aucun pays ne peut guère plus ouvrir ses portes à l'immigration en masse de n'importe quelle autre région du globe. D'autre part, même si cela était possible, la cadence de l'émigration, étant donné tous les problèmes à résoudre pour la réaliser avec succès, ne pourrait être assez rapide pour alléger de façon tangible et permanente les pays déjà surpeuplés. Ceux-ci comme nous-mêmes devront trouver dans leurs limites propres les solutions à leur problème.

Extraordinary claims of Chinese agriculture

India's Minister for Agriculture, Dr Panjabrao Desmukh, has published an article on what he found new in Chinese agriculture. Fields are divided into numerous small plots like beds in a vegetable garden with spaces between plots of 15 to 20 inches. This is done not only for vegetables but also for crops like groundnuts, soyabeans, maize, cotton and wheat. The amount of care taken in all aspects of cultivation is fantastic. Beds for all vegetable production are raised on the contour. Every possible piece of land, even the sloping sides of roadsides, are put to excellent use. No space is wasted anywhere.

What is entirely new in Chinese agriculture is the introduction of deep ploughing in the last two years. The whole of China is deep ploughing, an operation facilitated by the generally very soft nature of the soil and the even distribution of rainfall throughout the year. Most of the work is done by hand since the Chinese people have very few cattle. Deep ploughing is done in layer after layer, each layer being removed and set aside until the required depth has been reached. As digging moves forward the soil is put back mixed with manure, a few hollow bamboos being put at intervals for ventilation. Deep ploughing, or digging, is litterally deep digging, sometimes to depths of as much as 14 feet.

The second entirely new and novel feature of Chinese agriculture is the increased seed rate. Heavy seeding goes hand in hand with deep ploughing. With this combination, abundant manuring, daily watering, ventilation, control of pests and diseases and also artificial respiration through electric lighting, yields have been obtained under experiment the like of which has never been heard of in the world before. The sugarcane yield claimed is 94 tons per acre, a dozen times their 1957 yield. In the case of paddy a per acre yield of 115 tons is said to have been attained, with sweet potatoes 250 tons. This unbelievably high yield of paddy was obtained experimentally, the land bring tilled ten times before sowing and ploughed to a depth of 33 centimetres ; fertilizers were applied five times ; very close sowing was observed.

The Chinese farmers do not wait for pests to break out before spraying and dusting. In most places, they do these regularly and frequently. Similarly, they also administer doses of fertilizers with equal regularity. They get tobacco crops 10 to 12 feet high, sugar cane rising to 18 feet.

These high yields, under conditions of close planting and deep ploughing can only be obtained in regions where irrigation facilities are available in plenty; deep ploughing no doubt also ensures good drainage.

Dr. Deskmukh concludes by suggesting that India should undertake intensive experiments in the same way as the Chinese have done in at least twelve centres throughout its territory.

Enracinement des boutures sous abri plastique

On sait que pour faire prendre certaines boutures il faut un milieu constamment saturé d'humidité. Il en est ainsi avec le cacao et le thé dont les boutures sont mises soit dans des germoirs spéciaux, soit en planches recouvertes d'un épais paillis et maintenues toujours en état de sursaturation. Pour ce qui est du bouturage du cacao, le coût de l'opération est élevé et représente en valeur 4 à 5 livres de cacao sec. Avec des clones sélectionnés ce prix n'est pas prohibitif et on le récupère facilement par la suite avec les rendements supérieurs obtenus. C'est quand même cher. Aussi a-t-on recherché des moyens moins coûteux qui donneraient des résultats analogues.

A l'Institut de Recherches pour le Cacao, à Tafo, Ghana, A. D. Mackelvie a magnifiquement réussi en mettant les boutures sur planches ou en pots de papier recouverts de toile de polyéthylène. L'usage de cette substance plastique en horticulture n'est pas nouveau. Il offre l'avantage de retenir l'humidité tout en permettant le passage des gaz par diffusion à travers la toile. D'autre part cette toile est assez solide, est chimiquement inerte et n'est pas attaquée par les champignons. Les boutures ainsi recouvertes selon une technique facile à suivre prennent racine dans la proportion de près de 100 pour cent avec un minimum de dépenses et de main d'œuvre. On pourrait certainement s'en inspirer pour la reproduction rapide de clones de thé sélectionnés.

A litchi-drying experiment

The export of fresh litchi poses problems from the moment the fruit is picked to the moment it reaches the consumer overseas. Many of these problems disappear with the dried litchi.

The dried litchi is not likely to find much favour on the London market. Americans, however, like the taste of the dried litchi which they call "lychee nut", though of course litchi is not really a nut.

China which is the original home of the litchi, has a flourishing trade in dried litchi with the U.S.A. Canton is the centre of production. The fruit is dried on the cottage scale, two methods being in common use. By the first the litchi is dried in the sun; the ripe fruits are spread on the ground and turned over every day. After 10 to 12 days the outer skin has become brown and brittle, the inner flesh has become black. But if rain intervenes during the drying period the fruit gets

spoiled. The second method makes use of an open fire, the fruit being spread in single layers on trays made of bamboo mats placed high enough above the fire to prevent burning of the mats. In about 5 days the litchis are dried, but they are inferior to the sun-dried fruit.

Experiments carried out at the Agricultural Research Institute at Sabour, India, have shown that litchi fruits can be dehydrated in 16 hours in a cabinet-type drier having eight sliding trays accommodating 500 fruits each. The drying temperature was maintained at 130°F - 140°F. The humidity at the beginning was about 50 per cent reducing at the end to 5-10 per cent. Some 12-15 per cent wastage due mostly to cracking and shrivelling of the skin occurred. Such fruits were considered below standard and were discarded. The ratio of fresh to dried fruit was found to be nearly 3.5 : 1. Under the conditions of the experiment, the drying cost Re 1 per thousand fruits.

Essai d'un tracteur électrique

Le prototype d'un tracteur électrique, le premier de ce genre en Grande Bretagne, vient d'être essayé avec succès en Ecosse. D'après un porte-parole du ministère britannique de l'Energie, il s'agirait d'un tracteur actionné par un moteur à induction d'une puissance de 30 c.v. avec une transmission hydraulique, et équipé d'un cable de 500 yards de long.

Au cours des essais qui ont eu lieu aux environs de Falkirk des charrues à trois et quatre socs ont été accrochées derrière le tracteur et ont labouré sans difficulté des champs à terre extrêmement argileuse.

Sugar men meet next in Mauritius (1)

The International Sugar Cane Congress adjourned after naming Mauritius as the site of its next congress in 1962.

Dr. P. O. Wiehe will be general congress chairman. He is director of the Sugar Research Institute of Mauritius.

As general chairman of the 11th Congress of the International Society of Sugar Cane Technologists, Wiehe succeeds Dr. Leonard D. Baver, director of the Hawaiian Sugar Planters' Association Experiment Station who was general chairman of the 10th Congress just ended. Other new officers elected were R. R. Follet-Smith, chairman of the British West Indies Sugar Assn., general vice chairman, and Maurice Paturau, managing director of Forges Tardieu (machinery manufacturers) of Mauritius, general secretary-treasurer.

They succeed respectively Dr. St. J. P. Chilton, Louisiana scientist, and W. W. G. Moir, agriculturist.

As the site of the next congress, Mauritius was selected from four areas offering invitations — Mauritius, Puerto Rico, Cuba and Mexico.

(1) Extract from an article in *The Honolulu Advertiser* of 23rd May 1958.

INVESTIGATIONS ON THE CULTURE OF TILAPIA IN MAURITIUS

by

LIONEL JOHNSON

Part I — MANAGEMENT

I – Introduction

For many thousands of years the raising of fresh-water fish for human consumption has been practised in many parts of the world. The earliest records of such activity are Egyptian bas-reliefs, some 4,000 to 5,000 years old (Chimits 1958). These bas-reliefs depict various aspects of fish farming, indicating that not only did the fish provide food, but also recreation for the whole of the fish farmer's family. The accuracy of these bas-reliefs may be judged from the fact that it is possible to identify, in some cases, the species of fish actually employed. It is no mere coincidence that the species of fish used by the Egyptians is also used to-day in fish cultural work, and in fact it is one of the species introduced into Mauritius for such purposes — *Tilapia nilotica*.

In many other parts of the world fish-farming has been developed as circumstances have dictated, the deciding factor usually being the absence of sea-fish or the shortage of other animal protein. It has been found by experience over the centuries that the rate of production of fish is higher than that of any other form of livestock industry, and it is thus that in regions of intense population pressure on the land fish-farming is turned to as a means of obtaining the greatest return per acre.

In Central and Southern Europe, the cultivation of carp (*Cyprinus carpio*) has become an industry of considerable importance. In Germany the technique of cultivation has reached a high degree of refinement, and many of the principles established there have found application in other parts of the world with varying species of fish.

In the United Kingdom interest in fish-farming has declined since the days before the dissolution of the monasteries, when the cultivation of carp in "stew-ponds" was a feature of monastic life : providing the necessary fish for fast days. The decline is largely attributable to the increase of sea-fish in the diet due to improvements in the equipment and methods for exploiting the sea.

The fresh-water fisheries of South-East Asia have for many centuries been one of the major sources of animal protein : the production of fish in these regions is enormous and is a very significant factor in the nutrition of the population. In China especially the need for maximum production has stimulated the development of methods which are, in substance, similar to those evolved by the German workers. The main features are the use of a series of ponds for breeding, raising fry, and final fattening, and the use of organic and, in the European ponds, chemical fertilizers.

In Mauritius the cultivation of fish in " viviers " has a long history. The Gouramier *(Osphromenus goramy)* was introduced during the XVIIIth Century from South-East Asia. It feeds on aquatic vegetation and is therefore likely to compete with the more recently introduced species of Tilapia if cultivated together. It has, subsequent to introduction, become established in many of the fresh and brackish waters of the island. Other introductions, with a more sporting aim in view, have been the Black Bass (*Micropterus* sp.) and the Blue Gill (*Lepomis macrochirus*) both from the American continent, Dame Céré or Goldfish (*Carassius auratus*) and the Cus-Cus (*Etrophus* sp.) from the East.

At the present time, more interest has been shown in the cultivation of Carp or Kuhlia (*Dules rupestris*) and the Chitte (*Agonostomus telfari*) ; both are estuarine species which thrive in fresh water. Cultivation consists of removing fry from the rivers and keeping in a concrete tank supplied with running water. The fish are fed with poonac (coconut meal) until they are ready for the table, at a size of ten to fifteen inches. This and the similar cultivation of the Camaron (*Palaemon ornakus*) is not, however, of commercial significance, serving only the private needs of the owner. No figures are available as to the yields obtained under these conditions but a high stocking rate is possible, growth depending to a very large extent on the amount of food provided and not on manurial treatment of the water. There would appear no reason why this type of cultivation could not be increased in the warmer regions of the island to meet the needs of a small luxury trade. It is not anticipated, however, that yields would be as high as those of Tilapia due to the necessity of providing running water.

II – The place of fish farming in the agricultural economy

In recent years the scientific development of fish farming has taken place in most parts of the world, including Europe, the southern states of America, Israel, Africa and the Far East. This has been stimulated to a large extent by the world shortage of animal protein which has been greatly accentuated in the period following the last world war. Fish provide a valuable source of high quality protein which can readily be obtained in regions which do not support large livestock industries, and where land is either not available or else is not suitable for other agricultural enterprises.

The superiority of fish as a source of animal protein, where land is in short supply is indicated by the following table :—

TABLE 1. (Modified after F.A.O. (1954), Kalle (1948), and Mortimer (1954)). The level of production that may be expected from various livestock enterprises.

	Lowest yields per acre	Average yields	Maximum yields
Beef	5 lbs	80	250 lbs
Pork	50	250	500
Fish :			
Freshwater	less than 10	—	200
Germany (Carp)	25	200	500
Yugoslavia (Carp)	325	370	1400
Indonesia	250	1000	8000
Israel (Carp)	450	1650	5000
Belgian Congo (Tilapia)	600	2000	9300
U. S. A. (Bass & Blue Gill)... ...	45	170	375
North Sea	—	24	—
Mauritius (to date) (Tilapia).. ...	120	435	1130

When comparing yields per acre of fish and livestock, the actual amount of land required to produce a given return must be considered. In some cases quoted above, additional land must be included in the calculations to compensate for that land used to grow food for direct consumption by the fish. This is analogous to the feeding of dairy cattle on pasture with the provision of " concentrates " for high milk production, the land required for the production of the concentrates must be added to that of the pasture before any legitimate estimation of yields per acre can be made. The figures for Mauritius were obtained without additional feeding.

The high rate of productivity of fish under cultivated conditions is due in large measure to the feeding habit of the species involved. Most cultivated species are phytophagous or plant feeding ; in other cases they feed on insect larvae and other small crustaceans, which themselves feed on plants or bacteria. As the food chain is lengthened, as in the case of carnivorous fish, the efficiency of conversion from plant to fish is lowered at each step, and yields are consequently reduced. All natural waters contain minute plants, or algae, which have the power of very rapid multiplication, and which by suitable manurial treatments can be stimulated to multiply on a prodigious scale. It has been estimated that the total production of organisms, including bacteria (which can be used in the food chain) amounts to 350 tons per acre per annum (Carpart and Kufferath 1957), in ponds in good condition. If a conversion ratio of 1 : 7 is assumed for the conversion of plants to fish, the theoretical production should be in the region of 50 tons per annum. This of course assumes the total consumption of the food materials produced and would require the complete integration of the ecology of the various species employed, which would be impossible even under artificial

conditions. It does, however, give an indication that the maximum potential results are, at present, far from being obtained.

Under intensive agricultural conditions, the place of the farm fish pond is of great importance as it provides a rational end point to many operations ; it should therefore not be considered as an enterprise isolated from other aspects of farming. In Mauritius where there are no large areas of land suitable for fish farming, it is of great importance that the production of fish should provide an efficient link between the raising of other crops and the elimination of waste. Fish are the most efficient converters of many of the otherwise waste products on the farm, and the fish pond forms the most economical way of disposing of them. Pigs, poultry — especially ducks — and milking cows can have their housing so sited that the effluents discharge directly into the ponds. With all animals part of the food passes through the gut without complete digestion having taken place ; in the faeces therefore there is a quantity of food which can be used directly by the fish. The rest of the dung and the urine is used as a fertilizer for the production of algae.

Other waste products from the farm can be used for feeding. Chopped grass, groundnut haulms, banana leaves can all be used for direct feeding ; any other organic refuse can be piled in the corner of the pond to decompose and thus produce materials that will eventually provide nutrients for the life of the pond.

Where the pond is surrounded by cultivated land, there is always fertilizer and other nutrients being washed out of the soil into the pond. The amount may not be great, but it will add considerably to the natural fertility of the water.

The role of the pond in water conservation is also of importance ; the pond will store water during the wetter periods of the year which during the dry season can be used for irrigation and livestock. If the ponds are established in the upper reaches of a watershed, there can be considerable effect on the water economy of the lower reaches. The rate of run-off of the water is reduced in times of heavy rainfall and during dry periods the natural seepage and routine draining of the ponds will help to maintain flow in the rivers.

These varying aspects of fresh-water fisheries must be considered when estimating the value of any project of this nature. There is no doubt that the establishment of fish-ponds is of great value to the farm, since it combines so many excellent features in the overall economy, without taking into account the sporting and aesthetic value of the water. Unquestionably the addition of a pond enhances the beauty of an area and provides an excellent means of recreation.

In the complete analysis of fish-farming in the rural economy it is necessary to mention the labour requirements of such an enterprise. Once the pond is established, the work required in maintenance is very small, even with a high level of productivity. A few hours each week spent on a pond will suffice to carry out the routine operations, which include the addition of manure or ferti-

lizer, cleaning spillways, the removal of the vegetation from the banks of the pond and adding it to the water. Even this last factor can be eliminated by allowing animals to graze the banks.

III — The development of Tilapia in pond-culture

Although Tilapia have been used for several thousands of years in fish-culture, the use of this genus was not widespread and actual cultivation in Egypt probably declined after that country ceased to be a world power in the first century A. D. However, throughout Africa the importance of this genus cannot be underestimated. About half the animal protein consumed on this continent consists of fish of this type. The fishing industries on Lakes Victoria and Tanganyika depend almost entirely on the capture of *Tilapia* species (mainly *T. esculata* and *T. nilotica*). Lake Tchad alone produces some 30,000 tons of fish annually, based on the capture of *T. galilaea*, *T. nilotica* and *T. zilii*.

In spite of this, the systematic position of the genus was not adequately worked out until Boulenger (1909) provided the basis for subsequent work ; this was, until the last war, devoted mostly to the ecology and biology of the genus. All species do not possess the same potentialities for cultural work and cultivation is confined to about six species of the 100 existing. These species comprise *T. mossambica*, *T. nilotica*, *T. macrochir*, *T. zilii*, *T. melanopleura*, *T. esculenta* and *T. nigra*.

It was not until the Japanese occupation of the East Indies in 1941 that the potentialities of the fish were fully appreciated. During this period of occupation supplies of the fish normally used in this region (*Chanos chanos*) were in very short supply as fry were previously imported from China for fattening locally. Attention was therefore turned to *T. mossambica*, which happened to have found its way there. How this happened is not known, but it was probably imported as an aquarium fish in the first instance, subsequently escaping to the natural waters. The popularity of *Tilapia* rapidly increased and on the return of more peaceful conditions it was found that the *Tilapia* industry had become well established

Since the end of the war a great deal of interest has been evinced in the development of *Tilapia* fisheries in many other parts of the world. In East Africa and the Belgian Congo progress has been rapid ; in the West Indies, Madagascar and the Far East flourishing industries have been established. In fact it appears that *Tilapia* has done as much to increase the production of protein in tropical countries in recent years as any other livestock venture.

The reasons for the use of *Tilapia* under pond conditions in preference to other species of fish are many. *Tilapia* can be kept at a high rate of stocking in a pond without losing their capacity for growth and reproduction. Stocking rates up to 10,000 fish per acre can be achieved without loss, although this may not be the most economical rate for production. *Tilapia* can survive in water containing very little oxygen ; this fact is important in the manuring of ponds

with organic manures, which remove considerable quantities of oxygen during their decomposition. Tilapia can also withstand muddy conditions without apparently suffering. These attributes are desirable in any fish kept under intensive management, but the most important characters contributing to the success of *Tilapia* are their high growth rate, the quality of the flesh and the readiness with which they reproduce under pond conditions. Their high growth rate is due largely to their phytophagus habit and the fact that they can consume vast quantities of plant material. The feeding habits of the various species vary, some consuming microscopic plants and plant debris, others consuming almost any kind of vegetation from algae to grass.

IV — The principles of fish-farming

(i) *Pond design*

As with all livestock enterprises, the successful rearing of fish depends on good feeding and management. If this is not applied, then results will not compensate for the capital expended.

It is not sufficient in intensive cultivation to assume that any body of water is suitable for fish production. Fish can probably be raised is most waters, but yields will be a fraction of those obtainable under properly controlled conditions.

The siting of the pond should provide for an adequate supply of water at all times of the year, but the pond should not be constructed across a waterway. If this is done there will be continuous flow of water through the pond and this will go a long way to nullifying the advantages to be obtained from feeding and fertilization. In order to reduce to an absolute minimum the flow of water through the pond, the site should be away from steep slopes that will allow run-off water to enter the pond in excessive quantities during heavy rainfall. If such sites only are available, then the danger may be minimised to some extent by the construction of diversion drains around the side of the pond, although even if this is done the seepage below the drain may be considerable. The ideal site is one on fairly level ground, with a stream flowing close-by to supply water. The pond is then constructed by putting up a bank around the selected area, digging out the pond bottom to supply material for the embankment.

When erecting the bank great care should be exercised to make this as watertight as possible. All vegetation and top soil is removed from the land on which the bank is to be built and the sub-soil is worked in order to ensure that a good seal is made with the soil of the embankment. All vegetation is removed from the soil used in bank construction, otherwise it will decay with time and lacunæ will be formed through which water will eventually find its way. It is an advantage if the soil is of a heavy texture as this will hold water more satisfactorily than a light soil, but in either case it should be in a dry condition when construction is in progress. If soil is used when wet it will dry out at a later stage forming cracks through which water will pass.

The banks are given a slope of at least 3 : 1 on the inside in order to reduce erosion by wave action and to give most strength where the water pressure is greatest.

The depth of the pond need not be great, four feet at the deepest end is satisfactory, sloping upwards to a minimum depth of eighteen inches in the shallowest part. If the slope is regular, it will greatly facilitate draining the pond. If the pond is too deep the fish tend to migrate to the cooler regions during hot weather ; in this case they do not feed to the same extent as they will in the warmer waters above.

All ponds should be capable of being drained completely. This is necessary to control numbers in the pond and also to facilitate harvesting the fish. The simplest method is to insert a pipe and valve in the bank at the deepest part of the pond ; if the pipe is fixed into a small trench or "borrow-pit" dug below the main level of the pond bottom, draining will be facilitated. The pipe should be of a good size so that the water may be removed rapidly ; for small ponds up to half an acre a six inch pipe is sufficient, larger ponds of 1 to 2 acres will require a pipe of nine to twelve inches in diameter. The pipe must be set securely in position to avoid leakage at this point. Concrete facings at both ends and a concrete block in the centre will usually prevent any seepage along the line of the pipe. The valve should be placed on the outlet side of the pipe and should discharge into a small "fishery". The purpose of the fishery is to act as a strainer and to allow the water to pass whilst retaining the fish. The size of the fishery will depend on the size of the outlet pipe ; for a nine inch pipe a concrete or wooden structure 12' x 12', with one end open to take a removable screen will be adequate. The screen, which consists of heavy metal gauze of one quarter to one half inch mesh, is inserted in a groove in the fishery. If two sets of grooves are made and a second screen is available, one screen can be removed for cleaning during draining operations without stopping the flow of water. Screens on the pond side of the outlet should be avoided as these rapidly become clogged and unserviceable, causing much delay and inconvenience during draining.

It is advisable that all ponds be provided with a spillway to remove surplus water at times of heavy rainfall. The spillway is built by levelling a portion of the bank to the level of the water, and screening the opening to prevent the escape of fish. The floor of the spillway should be concreted to prevent erosion of the bank at this point, and a level board may be inserted to control the depth of water. The spillway should be several feet in width to enable a large volume of water to pass easily and quickly. If this is not done it will not be possible to dispose of the heavy rainfall that is experienced under cyclonic conditions and overflowing and loss of fish will result.

The water supply to the pond must be adequately protected to prevent the escape upstream of the fish. Tilapia have considerable powers of jumping and tend to move upstream whenever they have the opportunity ; fish have escaped under experimental conditions through a pipe discharging at a height of 18 inches above the level of the pond.

In China and the Far East the banks of the pond are often used for the growing of fruit trees and vegetables, but the growing of trees cannot be recommended as a general measure since the roots are likely to damage the banks and cause loss of water. There is also the further disadvantage that trees overshadowing the ponds will prevent the maximum sunshine falling on the water and this will reduce the energy available for the production of food. In addition the fall of leaves may cause blocking of the spillway ; in siting this it is an advantage to place it on the windward side of the pond in order that floating matter will be carried to the far bank.

(ii) *Methods of Management.*

All methods of management are designed to make the fullest possible use of the production of plants in the pond, and have been consequently developed to ensure a satisfactory balance between the amount of food available and the numbers of fish present to consume it.

The simplest method is to stock a pond with a single species and then to remove fish as they come to a marketable size. This can be done by continuous fishing with a line or seine ; in the latter case the mesh is adjusted to the size of fish it is required to remove. This continuous process has the advantage of regular production of fish through the whole year, which is desirable when the pond is used to feed the farmer and his family. By this method there is no loss of fertile water when the pond is drained. The great drawback to such a system is that control of the fish population is difficult to achieve ; this usually results in overstocking with small unmarketable fish. This occurs when, with continuing reproduction, the population outgrows its food supplies so that as numbers increase the size of the individuals becomes smaller. Steps must, therefore, be taken to remove the surplus fry at periodic intervals.

In the Belgian Congo (Huet 1949), a more refined method has been developed in which three or four different sized ponds are used to accommodate different sizes of fish. This is an adaptation of the method used for carp in Europe known as the Dubisch system. Single pairs of fish are placed in small spawning ponds which may be 36 to 60 square feet in area. As soon as the fry are old enough to be abandoned by their parents they are removed and placed in larger ponds. The rate of stocking can be very heavy and may be up to 60,000 fish per acre as the amount of food required by the fry is very small. When the fish reach a length of six to seven centimetres, at the age of two months, they are transferred to larger ponds where the rate of stocking is reduced to 4,000 to 6,000 per acre, or if artificial food is available the rate can be increased to 30,000 per acre. When the fish are 12 cms. long at an age of about 6 months, they are transferred to the main fattening pond at the rate of 1,000 to 2,000 per acre where they are allowed to grow until they reach a marketable size of 20 to 25 cms , after a further four to five months. The pond is then drained and restocked from the second stage pond. This system enables the available resources of each pond to be used to the maximum throughout the cycle. If fry are stocked in the fattening pond at the rate of 2,000 per acre the

production of food is greater than can be consumed by the fish in their early stages of growth ; it is only when they reach a size of about 15 cms. that food and fish will achieve a balance. Conversely, if the ponds are stocked heavily with young fish, food supplies will be short when the population reaches a greater size.

If this method is impracticable, as may be the case with the small farmer, it can be simplified by making a heavy initial stocking of fish of all sizes ; up to 1,000 lbs. of fish between 2 and 20 cms. in length may be added to the pond in the first instance, depending on the fertility of the water. Frequent fishing should be carried out to remove mature fish and finally at the end of eight months the ponds are drained completely and restocked at the same rate as previously. When the pond is drained the small and intermediate sized fish are retained and used for stocking on the next occasion, whilst the largest fish are marketed. This process necessitates having a small pond adjacent to the large one in which the fish for restocking are retained during drainage operations. In the Belgian Congo this method has produced yields of 1,000 to 1,500 lbs per acre.

As most species of *Tilapia* have somewhat different feeding habits, these methods can be varied by employing more than one species in the pond at the same time ; this further improves the utilization of the food supplies available. Of the species introduced into Mauritius, *T. melanopleura* can consume coarse vegetation and algae, *T. nilotica* cannot take the coarse vegetation to such an extent and live more on algae and *T. macrochir* take mostly algae and act as a scavenger in taking small particles of food from the pond bottom (see below). By combining one of the first two species with *T. macrochir* good utilization is achieved.

In some species of Tilapia, notably *T. macrochir* and *T. nilotica*, it is possible to differentiate the sexes at a relatively early age. When this can be done (Brown & Van Someven 1953) it is possible to discard the females and send only the males to the fattening pond. Although perhaps a little beyond the scope of many farmers this monosex culture offers great possibilities. The relative growth rate in the case of *T. macrochir* of males and females is about 1 ; 1.4 in favour of the males (*Eaux et Forêts* 1954). By this method the numbers in the pond can be rigidly controlled, and the draining of the ponds can be eliminated ; if mature fish are removed regularly, additional stock can be added to replace them. Occasional draining may be necessary as it is likely that a female may pass into the male pond unnoticed. Apart from control of numbers and the faster growth rates of the males, there is avoided the waste of potential which takes place when vast numbers of unwanted fry are produced.

(iii) *Manures and fertilizers.*

The successful cultivation of fish depends to a very large extent on the correct application of fertilizers and manures ; it is generally agreed that the colour of the water is a sound guide to its fertility and the need for additional fertilizing. The colour of the water is dependent on the amount of green plants

growing in it. A good green colour is obtained when adequate fertilizers are applied ; if the arm is extended in the water up to the elbow, the hand will be invisible if the water is supporting the correct algal growth.

The initial fertility of any natural water depends to a large extent on the fertility of the soil over which is flows (Capart and Kufferath 1957). In the pond, minerals, oxygen and carbon dioxide are combined in the presence of sunlight into bacteria and algae. Production continues until one factor becomes limiting. Usually this limiting factor is one of the minerals, which may be present in the natural waters only in small quantities. No further production takes place unless this supply is replenished, either by decomposition of organic matter, fresh supplies of water, release of nutrients from the pond mud or else by the addition of nutrients in the form of fertilizer or manure. Of the limiting factors likely to be of importance in pond culture, phosphate is perhaps the most usual. If a newly constructed pond is stocked with fish the yield will not represent the " fish value " of the water, since it has been found that in the first two or three years the yield gradually falls as the nutrients available in the soil of the pond become used up. When the value has reached a steady figure the value of the water alone for fish production can be accurately assessed. This figure represents the natural production, reference to which should be made when comparing the productivity of two natural waters. In the Curepipe district of Mauritius the basic production is approximately 120 lbs. per acre but is considerably greater than this in the lower regions of the island ; at Reduit 380 lbs. per acre have been obtained without additional fertilizers. Judging by the readiness with which a satisfactory colour may be obtained at lower altitudes the natural fertility is likely to increase as sea-level approaches. A similar situation is found in the Belgian Congo where fertility increases as one descends towards the sea ; here the fish-value is in the order of 500 lbs. per acre.

A large amount of work has been carried out on the effects of fertilizers in fish ponds which has been summarised by Mortimer (1954). As far as chemical fertilizers are concerned, all authorities are agreed that the two most important factors concern the addition of phosphates and lime.

(a) *Phosphates*

Phosphates are of great importance in the metabolism of bacteria and algae and considerable quantities are required annually to secure maximum production. Phosphates are absorbed on to the pond and are gradually released as required by the water. Due to this absorption there is no advantage in applying the phosphates in more than two doses during the year, many authorities advising the application of the total amount in one dressing.

(b) *Lime*

Lime is recognised as an essential element in the economy of the pond, and although fish can survive in ponds with a pH value of between 4 and 9 it is generally agreed that optimum conditions have been reached when the water is slightly on the alkaline side of neutrality. It is more and more becoming realised

that the pH of the water is not, however, the most important factor concerned with the addition of lime. The alkalinity of the water is considered to be of much greater significance and is a measure of the total base content of the water. The desirability of discarding the pH of the water as the determining factor for the addition of lime has been amply demonstrated at Curepipe. At this station the natural water has a pH range of 6.5 to 7.0 and in early experimental work it was not considered that there would be great value in the addition of lime. On determination of the alkalinity it was found that the calcium content was 3.6 to 5.0 parts per million and the lime requirements were in the region of 600 to 1,000 lbs. CaO per acre. The fluctuation of pH throughout the year appears to be related to some extent to the rainfall (Fig. 1). During the wetter parts of the year at Curepipe the pH is fairly constant, whereas during dry spells readings of pH 8 and 9 have been obtained. In spite of this the calcium content has remained very low. This is indicative of the need for heavy dressings of lime before satisfactory conditions for the growth of fish can be obtained. A further indication of the need for lime has been obtained from the examination of stomach contents where the presence of the Chrysophycean alga Dinobryum has been noted. This alga is characteristic of waters near neutrality, but low in calcium content (Small 1954).

The alkalinity can be determined by titrating 100 cc. of the water against N_{10} HCl, using methyl orange as indicator. The number of drops of the acid required to turn the indicator from yellow to orange-red indicates alkalinity. The following table by Schaperclaus (1933) gives the characteristics of the water at various alkalinities :—

Alaklinity, N HCl per litre or negative	Pond cultural significance, water strongly acid, unusable for hatchery purposes, adding lime to the water unprofitable in most cases.
0.1 — 0.5 cc. equivalent to 2 — 8 drops N_{10} HCl.	Alkalinity very low. Danger of fish dying, pH variable, carbon dioxide supply poor, water not very productive.
0.5 — 2 cc. equivalent to 8 — 30 drops N_{10} HCl.	pH variable, carbon dioxide supply and productivity medium.
2 — 5 cc. equivalent to 30 — 75 drops N_{10} HCl.	pH varies only between narrow carbon dioxide supply and productivity optimal.
Greater than 5 cc. equivalent to more than 75 drops N_{10} HCl.	Rarely found. pH very constant, productivity alleged to decline but not proven so far. Health of fish not endangered.

The functions of lime in fish ponds have been detailed by Wunder (1949) and may be summarised as follows :—

1. Neutralizes organic and inorganic acids.

2. Releases nutrients bound up in decaying matter and improves the physical condition of the pond bottom.

3. Necessary for bones and skeletal structures of invertebrates and fish.

4. Tends to destroy competitive and harmful organisms.

5. Producing a buffering action and enables large reservoirs of CO_2 which increases the fertility of the water as far as the plant life is concerned.

6. Fights fish diseases, especially gill-rot.

(c) *Nitrogen.*

The effects of nitrogen in any of the normal agricultural forms appears to be somewhat doubtful. In normal ponds the blue-green algae have a similar effect to that of legumes in conventional agriculture, in that they have the ability to "fix" atmospheric nitrogen, converting it into a form usable by other plants. The effects of adding nitrogen are therefore obscured, and conflicting results have been obtained. In America, Davison (1955) recommends a "complete" fertilizer mixture of 8-8-2 for the production of Black Bass and Blue Gills, applied at the rate of 800 — 1.600 lbs per acre. Depending on the natural fertility of the water. Most European authorities are doubtful about the effects obtained from the use of nitrogen. Little information is available under tropical conditions.

(d) *Sulphates.*

In Africa Beauchamp (1953) reports that sulphates can also be a limiting factor in the production of algae; it is reported that if the value for sulphate content of the water falls below 0.5 parts per million then the production of algae falls considerably. It may, therefore, be advisable to add nitrogen in the form of sulphate of ammonia, if there is any likelihood of sulphate deficiency, as may be the case in the upland districts of Mauritius.

(e) *Potash.*

There is undoubtedly a need for potash in the pond economy but it is difficult to arrive at precise requirements. It may be assumed that the normal agricultural application for the district will be a reasonably close approximation to the amount required.

The application of organic manure is undoubtedly of great benefit in increasing the productivity of a pond. In the Far East fish-farmers rely entirely on the use of this type of manure. Night-soil is considered the most valuable followed by pig, cow and poultry manure (Hoffman 1934).

All workers are agreed that fresh animal manure is one of the most efficient methods of fertilisation. The most economic way in which this can be pro-

FIG. 1

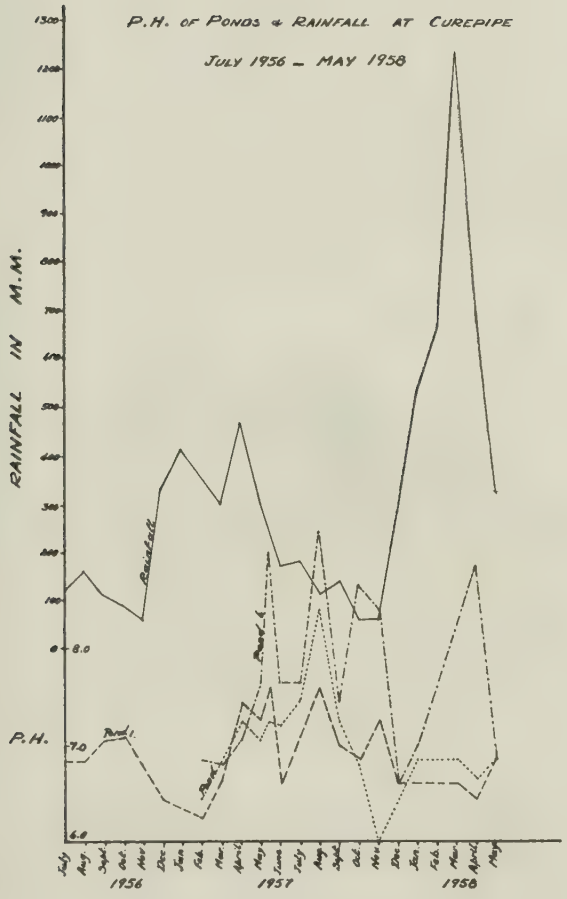
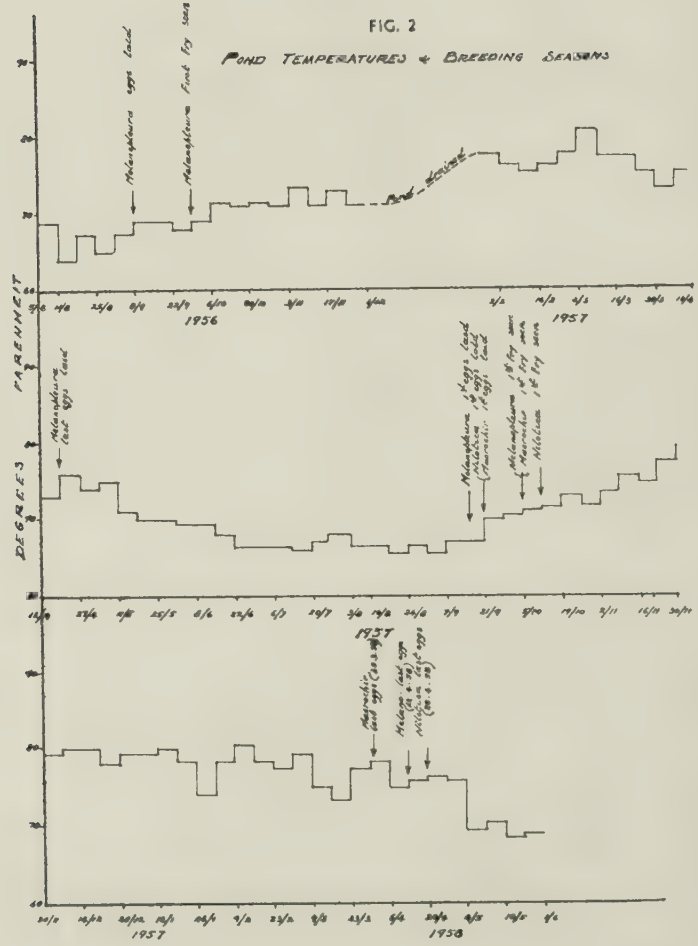

P.H. of Ponds & Rainfall at Curepipe
July 1956 – May 1958
RAINFALL IN M.M.
P.H.
8.0
7.0
6.0
1956
1957
1958

FIG. 2

POND TEMPERATURES & BREEDING SEASONS



vided is to combine other livestock enterprise with fish-farming, and the more that the livestock in the pond area can be increased the greater will be the return. In the Far East this has resulted in the erection of pig-sties, poultry houses and even latrines over the ponds in order to secure direct application of the manure and to reduce the labour required in cleaning the animal houses.

Other organic manures, such as saw-dust, straw and molasses which are high in carbohydrate, are not considered suitable for application once the pond has been established, but may be of some benefit in the early stages after construction (Demoll 1925). As molasses is a readily available food substance in Mauritius, small scale pond experiments were carried out to investigate the effects of the addition of this to the water. No appreciable change was obtained in the water colour in spite of applications up to the equivalent of 1 cwt. per acre per week. In laboratory cultures as dilute as 1 : 2,000 the molasses killed the algæ in a few days, and in no case did it appear that there was any stimulation of growth.

Other methods of increasing the fertility of the pond have been advocated by several workers Lin S. Y. (1940) writing of the new territories of Hong Kong recommends draining and exposing to the sun for several days, the mud is removed and the pond thus deepened at the same time. The mud is considered to be very valuable as a fertilizer for horticultural crops. Huet (1952) recommends the drying, cultivation and clearing of the pond bottom for the Belgian Congo. The drying and cultivation help to create a fertile colloidal organic mud by the process of mineralisation : it is also useful in removing rooted vegetation, and in destroying organisms and intermediate hosts of fish diseases. It is advised that cultivation should only be deep when the pond is very overgrown with reeds or when the soil is very productive ; where the mud is thin, cultivation should be light, followed by a dry period or a land crop.

If lime is to be applied it is best done at this time ; quicklime and slaked lime are poisonous to fish if applied to the pond directly. If applied when the pond is dry, it should be allowed to remain empty for at least a fortnight before restocking. Lime applied to the dry pond will help to control undesirable organisms and to eliminate any undesirable species of fish that may be present.

(iv) *Direct feeding.*

The production of fish from any area of water can be materially increased by the provision of food which can be consumed directly by the fish, without having to pass through the micro-organism stage. In countries where supplies of mill-wastes, such as those from rice, oil, starch or maize mills, are available, they may be fed in quantity. It has been estimated (Chimits 1955) that the application of seven pounds of the more concentrated feeds will produce one pound of fish. Unfortunately such feeds are not available in quantity in Mauritius and therefore no work has been carried out on this subject. All three species imported will accept this type of food.

Other materials which can be used for direct feeding include chopped

grass, banana leaves, manioc leaves or roots, and most other green crop residues. Again little work has yet been done on additional feeding of such materials, apart from small scale work on the feeding preferences of the fish.

V — Results of fertilizer and manurial trials

Most of the experimental work carried out in Mauritius has been done at the Curepipe Experimental Station which has an elevation of 1,800 ft. (549 m), an average winter temperature of 64.4 °F (18° C) and an annual rainfall of 131 ins. (3,275 mm). Most of the water supplying the fish ponds is derived from very heavily leached soils and therefore contains very little in the way of nutrients, although the pH is nearly neutral.

Trials were carried out in 1955 following Mortimer's (1954) recommendations for initial experimental work. These were as follows :—

(i) Unmanured control

(ii) 36 lbs. per acre of P_2O_5

(iii) As (ii) but with 45 lbs K_2O per acre

(iv) As (iii) but with 450-900 lbs lime per acre

(v) If liming has been carried out, then 45 lbs. per acre of nitrogen as the nitrate of ammonium salt.

During 1956 only *T. melanopleura* were available for large scale production, and all trials were therefore carried out with this species. In all trials to date a stocking rate of 2,000 fish per acre has been adopted. In the first year 374 lbs. per acre per annum were removed from the pond with a dressing of phosphates, potash and lime which was considerably greater than the yield obtained from the "control" pond (134 lbs. per acre), the ponds containing phosphates and lime (278 lbs. per acre) or phosphates alone (298 lbs. per acre). (See Table 3). From these figures one might conclude that potash was giving a significant increase over no potash. It is not likely, however, that this represents the true state of affairs, as all ponds suffered from an excessive flow of water through them. No ponds achieved a green colour indicative of adequate fertilizing.

As a result of these trials it was concluded at the time that lime was having little effect on the growth rate of the fish ; it was therefore excluded in the 1957 trials. This was, in the event, somewhat premature conclusion, but was nevertheless substantiated by the measurement of the pH which was around neutral.

In 1957 better water control had been brought about by the construction of diversionary ditches to remove surplus water draining from the hillsides. In this series of experiments with *T. melanopleura*, the maximum yield was achieved in a pond treated with nitrogen, phosphates and potash with manure

TABLE 3 — SUMMARY OF RESULTS OF FERTILIZER TRIALS

Pond		Treatment 1 acre	Species	Yield lbs/acre	REMARKS
1956	1	36 lbs. P_2O_5, 45 lbs. K_2O, 450 lbs. lime	*T. menalopleura*	374	Large flow of water through pond. Stocked with fry 3 — 7 cms.
	2	36 lbs. P_2O_5	— do —	298	— do —
	3	36 lbs. P_2O_5 450 „ Lime	— do —	278	— do —
	4	Control	— do —	134	— do —
1957	1	36 lbs. P_2O_5 45 lbs. K_2O + 20 tons manure 45 lbs. nitrogen	— do —	493	Water conditions improved. Stocked with fry 8 — 10 cms.
	2	36 lbs. P_2O_5 45 lbs. K_2O 45 lbs. nitrogen	— do —	187	Large flow but slightly improved. Stocked with fry 3 — 7 cms.
	3	36 lbs. P_2O_5 45 lbs. K_2O	— do —	180	— do —
	4	Control	— do —	116	— do —
	5	50 lbs P_2O_5 50 lbs. nitrogen 10 lbs. K_2O	*T. nilotica*	374	Water conditions quite good. Stocked with fry 3 — 7 cms.
	6	50 lbs. P_2O_5 50 lbs. nitrogen 10 lbs. K_2O	*T. melanopleura* *T. nilotica* *T. macrochir*	69 88 } 268 111	— do —

TABLE 3 (*contd.*)

Pond	Treatment 1 acre	Species	Yield lbs/acre	REMARKS
1957 7	50 lbs P_2O_5 50 lbs. nitrogen 10 lbs. K_2O	*T. macrochir*	290	Water conditions quite good. Stocked with fry 3 — 7 cms. Half population escaped upstream.
Irrig. Res. Reduit	NIL	*T. melanopleura*	380	Flowing water.
1958 1	100 lbs. P_2O_5 45 lbs. nitrogen 20 tons manure	*T. melanopleura*	665	Water conditions much improved. Ducks established on pond.
5	100 lbs. P_2O_5 45 lbs. nitrogen 20 tons manure	*T. nilotica* *T. macrochir*	1037	Water conditions much improved. Monosex culture.
6	100 lbs. P_2O_5 45 lbs. nitrogen 20 tons manure	*T. melanopleura* *T. nilotica* *T. macrochir*	150 100 } 430 180	Water conditions much improved.

in addition. The "fertilized" and the "control" ponds gave yields of 180, 187 and 116 lbs. per acre respectively.

T. nilotica and *T. macrochir* yielded 374 and 290 lbs. per acre respectively in ponds which had received fertilizer dressings only. A pond with a mixture of three species yielded 268 lbs. It is interesting to note that under these conditions *T. macrochir* made the greatest contribution of the yield. All these ponds had equivalent fertilizer applications.

Up to this date all stocking had been done with small fish of 6 to 10 cms. in length, as larger fish were not available in sufficient quantity to enable uniform stocking to be carried out with them.

By the beginning of 1958 the water control in the ponds had been further improved and larger fish were to be had in greater number On one pond which was stocked with *T. melanopleura*, ducks had been established as an ancillary project. With the addition of manure and fertilizer a yield of 665 lbs. was obtained. An even greater improvement was recorded in a second pond stocked with a mixture of the male fish of *T. nilotica* and *T. macrochir*; 1037 lbs. was obtained. In a pond containing all three species the yield recorded was 430 lbs. All the ponds in this series had manure and fertilizer dressings.

Difficulty was still being experienced in obtaining a good colour in the larger ponds, although in the smaller breeding and fry ponds this could be brought about quite readily.

Examination of these results indicates that there is a significant benefit to be obtained from the use of both manure and fertilizer, although of these, manure is perhaps the more important factor. It would also appear that a mixture of three species is not satisfactory. It is likely that the *T. nilotica* and *T. melanopleura* are competing for food with the result that the pond becomes overstocked.

In all ponds with *T. melanopleura* fry were produced in great quantity and undoubtedly produced a reduction in the yield of marketable fish. The other two species also bred in all ponds, except that devoted to male fish only, but not to such an extent as the *T. melanopleura*. Even in these latter two species the effect of eliminating breeding is very marked.

In 1957 two ponds were established at Pamplemousses Experimental Station. The soil in the area of these ponds consisted of a heavy clay and this greatly facilitated construction. The site also was such that no water could enter the ponds from the surrounding lands. Temperatures in the district, which has an elevation of 200 ft. (61 m) are on the average 6 to 7° F. higher than at Curepipe and the annual rainfall is 59 ins. (1,475 mm).

Under such circumstances a greatly improved water colour was readily obtained. This colour could be maintained by the use of fertilizer alone at the rate of :

200 lbs superphosphate
200 lbs sulphate of ammonia
40 lbs sulphate of potash.

Growth rates were very satisfactory, but no comparable yield figures have yet been obtained.

VI — Additional livestock

At Curepipe ducks have combined very satisfactorily with fish. It has been found that a similar system of management can be applied to them as to the fish. The ducklings on first going to the pond are penned with the growing fish ; as they become fully feathered they are transferred to the main flock on the fattening ponds. It appears that the excrement from the ducks provides a significant contribution to the fertilization of the water. The amount of food obtained by the ducks from the pond does not seem to be very great, but excellent condition is readily maintained.

The system normally employed for milk cattle in Mauritius of keeping the animals housed throughout the year is admirably suited to combining with fish-farming. A small shed has been constructed to house two milking cows on one of the ponds. The inlet flow of water has been diverted through the cow house to provide constant drinking water for the animals and the over-flow is so arranged as to pass along the dung passage, carrying with it all liquid excrement ; this materially assists in keeping the building clean. Litter and dung are readily disposed of through a trap door at the end of the dung passage discharging directly to the pond.

VII — Fish farming and sewage disposal

The use of fish in the purification of sewage water has reached a fairly high degree of efficiency in both tropical and temperate countries. The effluent, after passing through either an "activated sludge" or other process whereby decomposition is brought about, is suitably filtered to remove solid particles and diluted in the ratio of one to between three and ten according to the nature of the effluent. Fish can then be safely raised in the resulting water. After passing through the fish pond the water is equal in purity to that of most sewage disposal systems, provided that adequate checks are maintained and care is exercised. It is estimated (Kisshalt and Ilzhöfer 1937) that one hectare of pond is sufficient to provide for the needs of a town of 2,000 inhabitants. This system of sewage disposal has been applied with success in Munich (Kisshalt and Ilzhöfer 1937) where carp and trout were the fish employed and in Calcutta using three Eastern species, *Labeo rohita*, *Catla catla* and *Cinrhina mrigala*. (Nair 1944). In this way some of the waste associated with sewage is avoided ; all the soluble nutrients are reclaimed for the production of food.

Mortimer (1954) suggests that the waste products of distilleries might be treated in a similar manner, where disposal of the " dunder " causes a nuisance in the pollution of rivers.

There is a great difference between the use of screened sewage water and the use of night soil as carried out in the Far East. There is a danger in the use of raw night-soil in any agricultural undertaking, of spreading disease and internal parasites; such being the case its use is to be discouraged.

VII — Control of disease

As far as is known Tilapia do not suffer serious diseases, even when kept under very crowded conditions. The gill-rot associated with many other fish when similarly kept has not been experienced. Neither is Tilapia known to carry diseases which are communicable to man. Tape-worms of man which can in some cases have fish as their intermediate host, do not occur in Tilapia. These factors add materially to the value of this genus for cultural work.

Many of the most virulent tropical diseases are water-borne and in other cases the vectors of disease spend part of their life-cycle in water. It is therefore necessary that any body of water should be carefully watched to avoid this becoming a centre of infection.

Malarial mosquitoes breed in any still water, and certain measures may be necessary to avoid their breeding in fish ponds. The female mosquito, when laying eggs, alights on emergent or floating vegetation. It is therefore desirable that the edges of the pond should be kept clean, and that any floating material should be removed from the pond. One species, *T. melanopleura*, has the ability to eat most plants which grow in the water, and as such it is a very useful species in the control of vegetation in the pond. If other species are kept then it may be necessary to clean round the edges as the vegetation emerges. *T. melanopleura* is reported to be capable of consuming larvae of mosquitoes (de Bont 1948), although this has not been observed in Mauritius. In most waters in Mauritius the million (*Gambusia* sp.) can be found and this is a most effective predator on the larvae, and seems capable of keeping numbers well under control. However, this species tends to avoid masses of plants covering the surface; it may thus be necessary to remove such vegetation if it should occur.

Bilharzia or hook-worm is an animal that lives part of its life as a free swimming organism in fresh water; before it can become infective to man it must pass through a stage in the fresh-water snail. This snail is a plant feeder so that waters which carry little in the way of higher plants are not likely to carry a large population of snails. Again the advantage of stocking with *T. melanopleura* is obvious as it will cause all vegetation of this type to disappear.

IX — The improvement of extensive water bodies for fish production

As there are extensive inland waters in Mauritius some details on the improvement of fisheries in such water are necessary to complete the section on management. The fundamental factor controlling the growth of a population is the fertility of the water and the amount of fish food that results. In large ex-

panses of water it is unlikely that fertilization will be economic. It is therefore necessary to obtain the maximum production on the foods that are available naturally. As large fish consume more food per unit increase in weight than smaller ones below 25 cms. in length, all large fish should be removed by regular selective fishing : the use of a 5" (2.5" between knots) gill-net is recommended for this purpose. On the other hand careful control is necessary to prevent overfishing and the reduction of breeding stocks. Under extensive conditions most species of Tilapia take about four years to reach sexual maturity ; there is not likely to be the high production of fry therefore as is found under pond conditions. Protection of the breeding stock can be achieved by prohibiting fishing in the breeding areas, or providing a close season during which all fishing is prohibited.

In most waters in Mauritius, fish are present which will consume vast quantities of Tilapia if allowed to do so. The only method of control is by heavy fishing of these species, as it is unlikely that they could now be removed unless arrangements for draining can be made. The fish most likely to cause trouble in this respect is the Black Bass ; however, with heavy fishing of this species, it should be possible to establish an equilibrium between it and the Tilapia, as has been achieved in East Africa (Copley 1952). The other species such as Gouramier, Dame Céré and Blue Gill should also be fished heavily without any protection, as these species will compete with the Tilapia for food and are not such desirable economic species, since their growth rate is lower and their flesh inferior.

In smaller waters it may be possible to remove undesirable species by poisoning them. This can be done safely and satisfactorily by the application of quicklime to the water. This should be allowed to remain in the pond for at least a fortnight before restocking with Tilapia. A second method is by the use of rotenone (Derris extract), which is quite harmless to livestock and other vertebrates ; it quickly disappears from the pond and leaves no residual effect.

The use of drinking water reservoirs for fish production has been called into question on account of the possibility of spreading disease, but it is in fact likely that the reverse is the case. Worthington (1940) states :—

" Much of the work of the Freshwater Biological Association has shown the desirability of removing an annual crop (of fish) from reservoirs in order to keep the water in the best condition for supply and prevent cumulative effects which lead to production of troublesome forms of life such as algae and bacteria ".

The implications for Mauritius are of great importance, where there exists 3,100 acres of inland waters, the total production from which is at present negligible. If one assumes a minimum of 100 lbs. per acre, the total fish production in the island could be increased by 25 per cent. The further development of these waters for their amenity value could provide a great deal of pleasure and recreation in the form of boating and fishing. *(To be concluded)*

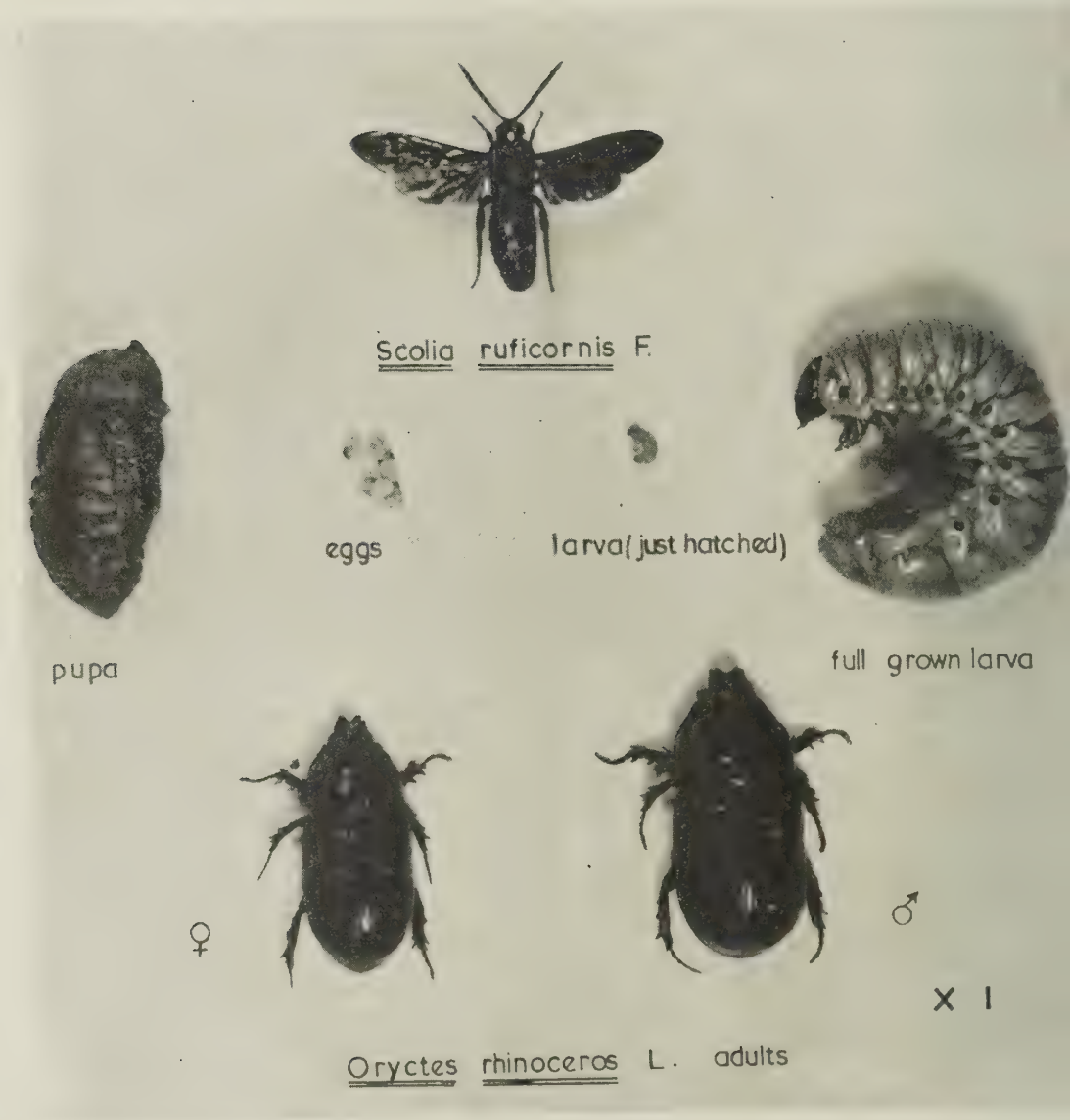


PLATE I — Stages in the life-cycle of *O. rhinoceros* L. and its parasite *S. ruficornis* F. (Nat. Size)

REPORT ON A VISIT TO DIEGO GARCIA

by

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- Diseases.
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I — INTRODUCTION

The writer left Mauritius per M. V. "SIR JULES" on the 1st October 1958 and reached Diego Garcia on the morning of the 9th. The "SIR JULES" left for Peros Banhos and Salomon, returning a few days later. The writer spent altogether 6 days in the island which he left on the 15th, arriving in Mauritius on the 23rd.

II — DIEGO GARCIA ; SITUATION, TOPOGRAPHY AND CLIMATE

Diego Garcia is the southernmost atoll of the Chagos Group, which is situated between the parallels of 4°44'S. and 7°41'S. and the meridians of 70°47'E. and 72°52'E., about midway between Ceylon and Mauritius. It is the most important island of the Archipelago ; its distance from Mauritius is 1,174 miles in a north-easterly direction. It is a typical atoll made up of a narrow ribbon of land varying in width from 30 yards to 1¼ mile and almost completely encircling a vast V-shaped lagoon opening to the ocean towards the north-west. Three small islands lie across the mouth of the lagoon, which is itself 13 miles long and 4 to 6 miles broad ; they are known by the names of West (1), Middle and East Islands (2).

Diego Garcia covers an area of about 6,000 acres ; the land is subject to alterations, being at times washed away in one part and raised at another. The whole of the land composing the atoll is very low ; the highest point being only 30 feet above high tide level and the general elevation 3 to 5 feet, so that the island appears to rise just above the waves. It is surrounded by reefs — the outer or seaward shore being higher than the inner or lagoon shore. Swamps formed by the sea or back-waters are fairly extensive in places. The strong tidal currents cause considerable beach erosion.

The nature of the soil varies a great deal from place to place consisting in some localities of bare coral rock while in others it is made up of calcareous sand and no coral. Also some parts of the land are older than others : these older parts have apparently been covered by vegetation for a considerable period for there is a thick peaty mould lying on the surface. According to Bourne, who visited the island in 1885, "the great strip of land which constitutes Diego" was formerly a series of disconnected islets which have since joined together by the accumulation of sand and coral debris between them. Deposits of guano occur here and there mixed with sand and marine shells or organic matter.

Diego Garcia was discovered by the Portuguese in the XVth century. It is named after two famous navigators of the same nationality :

(1) Or Bird Island or Isle Majaz.

(2) Or Isle Grand'Barbe — the largest of the three ; it is 800 yards long and nearly 100 yards broad.

Diego Diaz and Garcia de Noronha. When first discovered, it was already covered by a luxuriant vegetation of coconut palms, of tatamaka (*Calophyllum inophyllum* L.), of bois blanc (*Hernandia peltata* Meissn), and of gayac (*Intsia bijuba* O. Ktze). The whole island is now devoted to the cultivation of the coconut, but its central part " was evidently at one time a large garden for taro : *Calocasia antiquorum* Schott " (3) (Plate II).

Before the piercing of the Suez Canal, Diego Garcia was a coaling station for ships going to Australia from Aden and back while earlier still it was a safe shelter for 17th and 18th century privateers. It was visited in August 1914 by the famous German battleship " Emden ". As there was no wireless in those days, the population, ignorant of the outbreak of war, allowed the ship to load its full complement of fuel and fresh food... only to learn of hostilities between Britain and Germany from a British destroyer 24 hours after the Emden had left. During the last war it was one of the bases held by the R.A.F. and R.A. in the Indian Ocean.

The Archipelago lies on the southern limit of the North-west monsoon and winds at that season are from N.E. through N.W. to West. The S.E. trade wind prevails from April to October, blowing with persistence from June to September. Fortunately a natural windbreak is provided by the almost unbroken zone of *Scaevola frutescens* Krause (Bois manioc), *Thespesia populnea* Soland, and of *Tournefortia argentea*, L. (Veloutier). Calms are very rare and cyclones do not occur. The climate is typically equatorial ; the temperature varies little throughout the year and rarely exceeds 32°C or falls below 22°C. The weather is coolest when the S.E. Trade Wind is at its strongest. The dry season lasts from June to September and the wet season from October to March. The rainfall is high with fairly great variations. In 1957 it was 128 inches and this year (September 1957 — August, 1958) it dropped to 88.5 inches.

High rainfall and temperature, absence of cyclones and a constant supply of soil water can easily explain the dense vegetation which is to be found everywhere except where the soil conditions constitute a limiting factor. These conditions are responsible for the absence of a distinct flowering season and for the gigantic size of many native and cultivated trees (Wiehe 1939). The atoll is covered with luxuriant vegetation of bright green colour and is fringed by pure white sandy beaches. In places the tree-line is 125 feet high, while clumps of *Casuarina equisetifolia* Forst., reach 80 feet or more.

III — THE COCONUT PLANTATIONS AND THE COCONUT INDUSTRY

The main industry of the island is the production of copra ; this is exported to Mauritius where oil is extracted and the press-cake or poo-

(3) Taro : *songe creole*. It is called " Via " in Diego. However, the plant called " Via " in Mauritius is different and its scientific name is *Typhonodorum lindleyanum* Schott — a giant arum.

nac is valuable when added to poultry feed mixtures. Some guano is also exported. Table I summarises the island's production.

TABLE I

Year	No. of nuts collected	Weight in tons of copra exported to Mauritius	Weight of copra used for Diego edible oil requirements	Remarks
1957	4,817,000	590	34 tons	In addition 16,000 nuts were used in seedling production
1958	4,514,000	558	36 ,,	This is equivalent to 26,520 bottles of oil

This year's guano production amounted to 1,425 tons. In addition 800 tons are in stock at Diego.

NATURAL AND ARTIFICIAL GROVES

The coconut groves are nearly all natural plantations which are very old; as a result yields are going down. In places the palms are intermingled with trees and other dense undergrowth on which grow epiphytic ferns, such as *Asplenium nidus* L. (an edible species commonly called " langue de vache "), while at their base and on the ground are thick tufts of *Psilotum triquetrum* Sw. thus forming an inextricable jungle. Owing to the dense foliage and the very low light intensity resulting therefrom, the palms are sometimes bent, with spirally twisted trunks.

A tremendous effort in replanting has been made in the past few years and regular plantations of the palm are now to be found e.g. at Nordest, East Point and Carcasse.

In striking contrast with the compact undergrowth of the natural groves, the vegetation of artificial groves changes to creeping plants associated with noxious weeds such as *Tridax procumbens* L. (Herbe caille), *Fimbrystilis spathacea* Rath. (Herbe malgache), *Bryophyllum pinnatum* Kurze (Soudefafe), *Stachytarpheta indica* Vahl (Queue de rat), *Achyrantes aspera* L. (Herbe sergent), *Stenotaphrum dimidiatum* (4) Bronqn. (Chiendent bourrique), *Bidens pilosa* L. (Villebague), *Ageratum conyzoides* L. (Herbe boue), *Boerhaavia diffusa* L. (Liane nina), *Portulaca oleracea* L. (Purslane, pourpier), *Passiflora suberosa* L. (Liane poc-poc)

(4) In many places this grass suffers from " chlorosis " probably due to some mineral deficiency.

Plate II — A plantation underplanted with seedlings.
Colocasia antiquorum in foreground.

Plate III. — Group of palms dying from rhinoceros beetle attack.

Plate IV. — Abnormal growth of roots resulting from husks piled around base of palm. The stem above the root growth shows attack by the stem bleeding disease.

Plate V. — A coconut grove attacked by *O. rhinoceros* L. The palm on the left with a central tuft of abnormally small fronds also suffers from " pencil point " disease.

and the ubiquitous shrub *Morinda citrifolia* L. (Bois tortue). Plants making up the beach community are frequently parasitized by *Cassytha filiformis* L. (Liane sans fin).

A large number of nuts are lost through germination. In the past, planting was only carried out to replace dead trees, and small holes were made in which self-sown seedlings removed with a hoe were planted (hence the name " coco-pioche "). This practice has disappeared altogether and large holes are now dug (3—7' diameter and from 4-10' deep according to the water table) and the hard pan underlying the surface is thoroughly broken. The establishment of seedlings is therefore not as slow as before and better trees result. Selection of seedlings, however, is not effected in nurseries. Nor is manuring of established plantations practised. It might be advantageous to use some of the lower grade guano to improve the soil in deficient areas. The only manuring is at planting time in the hole dug which is filled with organic matter and ash from burnt coir and coconut leaves.

Weeding is an important problem and is done by hand : gangs of labourers simply cutting down and burning the undergrowth from which some charcoal is made at the same time. Weed-killers are not used ; should such be employed great care should be exercised to prevent injury to the coconut trees. A flame thrower might perhaps be used where *Bryophyllum* (soudefafe) is plentiful.

Ripe nuts are allowed to fall on the ground ; these are collected weekly and the husks removed. Formerly the husks instead of being burnt were stacked round the trunks of the palms up to a height of 3-4 feet. This practice favoured the development of the rhinoceros beetle and also of adventitious roots along the trunk (Plate IV). The de-husked nuts are transported in donkey-drawn carts and the meat is dried in the copra-kilns at East Point. Formerly the kernels were broken and the meat then spread on drying platforms with sliding corrugated iron roofs. Sun drying has sometimes to be resorted to, but it is altogether an unsatisfactory operation for should rain occur the wet copra does not keep and becomes rancid and mouldy. It is also more readily attacked by the copra beetle (*Necrobia rufipes* Deg.) (5) than kiln-dried copra.

Owing to the small size of the nuts, about 8,000 to 8,500 nuts are required for 1 ton of copra.

INSECT ENEMIES OF THE COCONUT PALM

About 800 insects have been recorded throughout the world on the coconut palm. Of these, nearly 25% are specific to the genus *Cocos*. Only about half a dozen have so far gained access to Diego. Top of the list comes the rhinoceros beetle.

(5) COLEOPTERA : Family Corynetidae (Cleridae). It is a small metallic blue beetle with reddish legs measuring 3.5 mm to 6 mm. in length.

The following is a list of coconut pests in Diego :—

TABLE II

Pests	Insect Order	Notes
(1) *Oryctes rhinoceros* L.	Coleoptera : Scarabaeidae	Commonly called the rhinoceros beetle
(2) *Aspidiotus destructor* Sign.	Hemiptera: Coccoidea-Diaspidae	The coconut scale
(3) *Chrysomphalus ficus* Ashm.	— do —	A round flat scale
(4) *Pseudococcus adonidum* L.	Hemiptera: Pseudococcidae	A white fluffy mealy bug
(5) *Pseudococcus* sp.	— do —	— do —

Aspidiotus destructor Sign.

This is the widespread coconut scale. It is a Diaspine coccid which also attacks a wide range of plants, including the banana, mango, papaw, avocado, breadfruit and *Barringtonia* sp. (Bonnet de prêtre). This leaf pest is covered by a flat delicate waxy and semi-transparent scale. The male scales have an oval outline, the female scales are circular. The eggs hatch under the scale and the larvae crawl out slowly in search of a suitable place to fix themselves by inserting their rostra into the leaf. The spread takes place in a number of ways: human agency (coconut leaf baskets), insects, birds and wind. *Chilocorus nigritus* F., a coccinellid beetle or lady bird introduced earlier from Mauritius was recovered but was present in insufficient numbers to check the scale. Thus, at Nordest a number of young coconut palms were severely attacked. The young fronds showed pronounced yellow and brown dying leaflets. The scales were so numerous as to form a continuous light brown crust on the undersurface of the entire fronds. There are indications that a few palms have been killed by this scale and not by the rhinoceros beetle.

It is suggested that new importations of *C. nigritus* be made from Mauritius. Another coccinellid *Cryptognatha nodiceps* Muls. present in Trinidad and Fiji could also be tried as its introduction into the latter islands was very successful against *Aspidiotus*.

It may be mentioned that the following ladybirds also prey upon *Aspidiotus* : — *Scymnus oblongosignatus* Muls., *Scymnus* sp. *Scymnomor-*

plus sp., *Lindorus lophanthae* Blaisd., *Exochomus laeviusculus* Wsc., *Chilochorus politus* Muls. As these occur in Mauritius, it is also suggested that one or more of these insects be introduced into Diego for trial. An alternative control measure on small palms is to use a 0.2% malathion solution followed by an application of parathion, but as these substances are organophosphorus chemicals, they can only be used under expert guidance.

Chrysomphalus ficus Ashm. is another Diaspine coccid present in Diego Garcia. It is a round flat scale which can be controlled by coccinellids or by chemical treatment.

Pseudococcus spp.

These mealy bugs are common everywhere and are tended by ants; more commonly by *Technomyrmex detorquens* Wik. The ants intensify the attacks by carrying the young stages from leaf to leaf and palm to palm and warding off parasitic and predaceous insects. To keep the ants off, monthly sprayings with 0.5% chlordane might be made, when no other treatment of the palms is necessary.

Acarina

In a number of cases the palms showed signs of attack apparently by a mite; but in spite of repeated searches, the mite *Raoiella indica* Hirst was not encountered during the author's inspections of the groves. This does not rule out its presence in the island and investigations at other periods of the year would be necessary to find out whether it is present or not.

DISEASES OF THE COCONUT PALM

The author ventures to make the following remarks on some diseases of the coconut palm which he observed during his visit: *Bud rot*, *Stem rot* and *Stem bleeding disease*, *Yellowing*, *Leaf spot*, *Quick tapering* and *Premature nutfall*.

Bud-rot — This disease fortunately is not very common. A few cases were seen at East Point, at Cimetière " Zenfan ", and at Noroit. The attacked trees which are growing on unsuitable soil, seem also to have been adversely affected by strong winds. The only control measure advocated if the disease develops in epidemic proportion is burning down of affected trees.

Stem-rot and Stem bleeding — This occurs throughout the island. The symptoms are fairly easy to detect and are characterized by the formation of drops of brown ooze from the bark which is cracked in a number of places, and of reddish-brown or dark streaks along the stem. The pathogen is a fungus *Ceratostomella paradoxa* (de Seynes) Dade. In advanced cases of the disease, large cavities appear inside the stem.

(Plate IV, trunk above abnormal roots). More than a score of heavily affected trees were counted in different places. Although the vigour of the palms is obviously impaired as a result of this disease, crops of nuts were present in all cases encountered.

The diseases known as "knife-cut" and "little leaf" were not seen although in one case large gashes were found on a palm, but it was difficult to decide whether the effects were due to human agency or to natural causes.

Yellowing — Pronounced leaf yellowing is common at a number of places. Sometimes it is restricted to occasional trees, at other times a fairly large area is affected, as for example at Carcasse, Verger, Canoterie, Aux puits. As pointed out already the mite *Raoiella* was not encountered in the island ; the yellowing might be of pathological nature or be due to some unfavourable soil condition. A soil survey or possibly a study of soil profiles only might throw light on the problem.

Leaf spot caused by *Pestalozzia palmarum* Cke. is of extremely frequent occurrence resulting sometimes in a severe blight on young seedlings.

Tapering stem wilt or pencil point disease — In some areas the palms are apparently affected by a disease which involves rapid shrinkage in diameter, barrenness and yellowing of the tips. In advanced cases the decrease in leaf area and in stem diameter is such that the crown fails to produce leaves and dies (Plate V).

Premature nutfall — The fall of immature nuts (button nuts) within 2 months of the emergence of the spadix is a normal phenomenon. At a later stage when the endosperm of the fruit is just being formed nutfall must be attributed to insect attack or to some other adverse factor. It is known that attacks of the bug *Amblypelta cocophaga* China in some countries (e.g. British Solomon Islands Protectorate) leads to premature fruit fall, but as neither this insect nor any allied form was encountered, the cause of the trouble must be looked for elsewhere. In any case large losses of potential crop result and the problem deserves closer attention as in some areas a considerable number of trees are non-bearing.

Lightning injury

A number of trees were found with the dead leaves still attached to the crown ; as their death could not be attributed to commonly occurring causes, it is possible that they had been struck by lightning. These trees decay rapidly and serve as breeding ground for the rhinoceros beetle.

The Rat Problem

The rat problem at Diego is comparable in magnitude to the

ravages of the rhinoceros beetle. According to observations and calculations an increase of more than $\frac{1}{4}$ of the nuts collected could be obtained were it not for destruction by rats.

An abstract from Charles Regnaud's book on the coconut (6) concerning damage to coconuts by rats is worth quoting as it explains the nature of the injury caused by this pest:—

> « Il y a 240 ans que Pyrard écrivait : « Les rats ne s'attaquent qu'à ceux qui sont encore verts (les fruits), à cause que les secs sont trop durs à ronger, point que ces animaux désirent principalement d'en boire l'eau et ont cette industrie de faire un trou par dessus, de peur que l'eau ne se répande, et font ce trou de leur même grosseur, afin qu'ils puissent entrer dedans pour boire et manger ; et quand ce fruit n'a plus de substance dedans, il s'empire et tombe de telle sorte qu'aux îles non peuplées la terre en est couverte.....
>
> Ces petits quadrupèdes n'ont pas changé de mœurs, depuis l'époque où Pyrard a signalé leurs dévastations. Ils pullulent encore dans toutes les îles où sont répandus les cocotiers... Le plus souvent, les rats entament le coco tout autour du point où il adhère à son calice persistant, en cet endroit le fruit est très tendre : aussi ont-ils bientôt atteint la noix, qui n'a pas encore atteint la dureté qu'elle doit offrir plus tard et fait leurs délices de la crème et de l'eau qu'elle contient. Chose assez singulière, les rats s'attaquent indifféremment aux cocos encore très jeunes, ou à ceux qui ont déjà acquis toute leur grosseur ; ils creusent même ceux qui ne sont pas plus gros qu'un œuf d'oie.....
>
> Dans quelques-unes des îles de la mer de l'Inde, qui sont sous la dépendance de Maurice on a introduit des chats, espérant ainsi détruire ou du moins diminuer le nombre des rats : mais on n'a pas tardé à s'apercevoir que les chats dévoraient exclusivement les jeunes oiseaux de mer qui leur offraient une pâture plus délicate et infiniment plus facile à se procurer. On à souvent recours, dans ces mêmes îles, à un moyen analogue a celui employé dans certaines parties de la France pour la destruction des taupes. On a des *chercheurs de rats* : ce sont des noirs qui, en outre de la paye mensuelle, reçoivent la gratification d'un verre de rhum par douzaine de queues de rats qu'ils rapportent à l'établissement ; mais ce moyen est encore insuffisant »...

Besides cats, dogs were introduced in Diego to destroy the rats ; the attempt was not a success, as the dogs were not of the right type and they are now but degenerate mongrels which constitute a nuisance and should, in their turn, be exterminated. Introduction of the mongoose

(6) Histoire Naturelle, hygiénique et économique du cocotier. Paris 1806. pp. 22-23.

must be ruled out for obvious reasons. Trapping is not very efficient as only about 600 rats were destroyed by that means from September 1957 to August 1958. Reference is here made to an article (7) by J. R. Williams, former Entomologist of the Department of Agriculture on rat control and it is recommended that those interested in the problem in Diego should read the article.

Poison should be used with great caution, because after eating certain toxic substances, rats run for water and in Diego drinking water is in many cases obtained from wells. Substances containing warfarin, which give good results when properly used, should in the author's opinion be the type of poison to try.

Metal shields or strips of tin, something like an open small umbrella might be nailed round the palms in such a fashion that the lower rim stands out from the trunk, thus preventing ascent. This, however, is a costly job for in saline air metal corrosion is rapid and owing to increase in girth of the trees the shields burst.

BIOLOGICAL ASSOCIATIONS

A word might here be introduced about the origin of the coconut palm. Botanists generally accept O. F. Cook's views about the American origin of the coconut palm (1901), but this seems inadmissible for the crab *Birgus latro* Hbst. does not occur in American coasts and it is improbable that such an organism could have been evolved independently of the coconut.

At the time of my visit this crab (commonly called the Robber Crab or the " Cipaye ") seemed very scarce. According to the Manager it does not at the moment cause important losses.

On the other hand, the large red crab, *Cardisoma carnifex* Hbst. (commonly called " troulourou ") causes severe depredations in vegetable gardens ; further they seriously damage the only road which crosses the island. They could be controlled by pesticide treatment.

IV — THE RHINOCEROS BEETLE

Before discussing methods for the control of *Oryctes rhinoceros* L., it is necessary to review briefly its life cycle and its effects upon the growth of the coconut palm. It is an Asiatic beetle which probably gained access to Diego Garcia during World War I, " being already firmly established in 1939 in some localities " (Wiehe). It now menaces the entire production of copra and consequently of poonac.

Notes on the life-cycle

The length of the life cycle of the insect from egg to adult has

(7) Field rats on sugar estates and methods for their control. *Rev. Agric. Maur.* 32 : 2 : 1953 pp. 50-00.

been variously assessed. Ghosh (1911) regarded it as being 336 days. Corbett (1932) found the minimum time, under laboratory conditions, to be just under four months and the maximum just over $9\frac{1}{2}$ months, while other writers have found it to be 2 years. Obviously it varies with temperature and humidity. The adults occur throughout the year, but are more abundant from January to May. They lie in concealment during day-time and begin their flight at dusk, when they attack the coconut palm and burrow into its heart. Sometimes they simply bite through the folded leaf so that when it unfolds later, the leaflets are found perforated or cut symmetrically off. At other times they bite right through to the growing point and the tree is doomed.

The adult has been found to live for just under $3\frac{1}{2}$ months under laboratory conditions. The female starts laying about one month after emergence and the total number of eggs varies between 27 and 60. They are placed singly, or a few at a time, in decaying palm stems or humus-laden rubbish heaps. The eggs average 3.5 mm by 2 mm (Plate I) ; they are creamy white in colour and increase considerably in size before hatching ; they are often surrounded with hardened earth.

In Diego, under fairly humid conditions they hatch in about 8 days. The newly-hatched larva or grub measures 5-6 mm in length (Plate I). As many as 40 to 100 larvae have been counted in a few feet of coconut stem. Dead trees are soon converted into a damp brown powdery mass, and it has been calculated that over a thousand beetles can be bred from a rotten coconut tree before it is quite destroyed.

The grub lies on its side ; it is fleshy and translucent and has three stages of development ; when full grown it measures 70 mm x 25 mm. It has a large brown head with powerful black mandibles. The body is covered with numerous reddish bristles and reddish brown spiracles occur along its sides ; the anal segment is very swollen. Larval life averages four months. The grub finally enters the pupal stage which is of short duration, so that pupae are comparatively rare to find. The pupa is at first white but later turns brown. The size varies, but is generally about 48 mm by 20 mm. The sex is indicated by the size of the horn on the head which as in the adult is prominent in the male. The adult beetle is very hard and chitinous almost shining black above and reddish brown below and measuring from 50 to 65 mm by 20 to 35 mm. When it emerges from the pupa, it is yellowish to brown in colour ; the thorax is notched and scooped out in front toward the head. The elytra are smooth with longitudinal grooves and fine punctures. The legs are stout, spiny and adapted for digging.

Campaign of eradication

Prior to 1951, the Entomology Division of the Department of Agriculture supplied Diego Ltd. with several colonies of *Scolia oryctophaga* Coq. for release in the atoll, apparently without result. In

November of the same year, N. L. H. Krauss, who was collecting *Scolia ruficornis* F. in Zanzibar for despatch to American possessions in the Pacific, kindly sent two consignments of the wasp (Plate I) to Mauritius for forwarding to Diego Garcia. The following table summarizes the position in December, 1951.

TABLE III — Shipment of *S. ruficornis* F. from Zanzibar to Diego Garcia

Shipment No.	Date sent from Zanzibar	No. sent from Zanzibar	Date of arrival in Mauritius	No. received in Mauritius		Date sent from Mauritius to Diego	No. sent from Mauritius to Diego
				Alive	Dead		
1	19.11.51	60 ♀♀ 10 ♂♂	22.11.51	55 ♀♀ 8 ♂♂	5 ♀♀ 2 ♂♂	7.1.51	36 ♀♀
2	29.11.51	64 ♀♀ 6 ♂♂	3.12.51	56 ♀♀ 6 ♂♂	8 ♀♀ —	7.12.51	53 ♀♀ 6 ♂♂

The total shipped to Diego was thus 89 ♀♀ and 6 ♂♂. The wasps became established and were recovered in 1956. The writer this year collected about a hundred wasps at East Point and Paille Sec. In spite of these recoveries, it is evident that the control of *Oryctes rhinoceros* (L) through scolid wasps has not yet proved its effectiveness and that infestation remains chronic throughout the island. The Manager of the island seeing that the percentage paratism is negligible started a campaign of collection and destruction of the eggs, larvae and adult beetles (8). The total catch during the past year (September 1957 to August 1958) has been 691,657. During my short stay in Diego Garcia the catch consisted of 40 eggs, 854 larvae, 34 pupae and 51 adults (27 ♂♂ and 24 ♀♀). Not one of these larvae was parasitized.

Suggestions for dealing with the beetle

The problem of rhinoceros beetle control is now complicated by the fact that nut production is falling, this being due to the old age of the trees. Although an intensive programme of replanting has been start-

(8) The usual method of destruction of the adult is to employ labourers (especially women) provided with a long flexible iron wire terminated by a barb with which to spear the beetle in its burrow at the base of the leaf stalks. (Incidentally this method is also employed in India where a « beetle rod », i.e. an iron rod 2 1/2 feet x 3/8 " with a hook at one end and another end bent to form a ring for a handle, is used. — Ref. Clerian, M. C. & Anatanarrayanan, K. P., *Indian J. Agric. Sci.* 1939. 9 : 571-599). Attacks can easily be seen because of the pre ence of « dead hearts » or central fronds killed by the beetle.

Countings of all stages of the beetle are then made and payment is 3 eggs, larvae or adults for one cent. Another method is to attract the adults by small fires at night and beat them into the fire while larvae are destroyed in trap logs. The author finds the economic value of the methods of collection uncertain.

ed, out of 16,000 seedlings planted last year, already a third have died through attacks of the beetle which is now, and has been for the past few years, a pest of considerable importance in the island. The writer therefore feels that a new approach to its control should be made :—

1o. The use of insecticides should be introduced to ensure the protection of palms in their first years of life.

2o. Improved methods of destruction of the larvae should be enforced together with insecticidal treatment of compost pits and refuse heaps.

3o. New parasites should be sent to Diego Garcia, for biological control has one great advantage : its effects are usually permanent and once achieved it requires no further attention.

Insecticidal control

Treatment of crown of young palms : B. A. O'Connor after seeing a report of the Indian Central Coconut Committee (9) and experimenting with BHC - sawdust mixtures in Fiji recommends the following :— " Placing a mixture of one part by volume of a BHC formulation in nine parts of damp saw dust in the axils of the youngest four or five fronds of every palm (10). The two formulations which have been commonly used are the dispersible powders containing 6.5% and 10% gamma isomer respectively ". A wettable powder containing 32% diazinon mixed with sawdust is more effective but unfortunately more expensive (11). I am also informed that 2% dieldrin granules applied around the base of the growing tips of young coconut palms seems likely to prevent damage.

Treatment of compost heaps, dung, etc — Intensive breeding having been observed in dung heaps, it is imperative to treat these with Agrocide 26, a new gammexane formulation now just available on the local market.

Treatment of beetle holes — As already stated adult beetles are usually speared or harpooned inside their holes at the base of the leaf stalks. It is essential that the holes in the palms be plugged with the mixture recommended above for crown treatment as other beetles have been observed to enter old holes on a number of occasions. It might also be useful to add a compatible fungicide to the mixture for in a number of cases a rot follows attacks of the beetle.

The use of trap logs.

After having seen the labourers search for grubs in trap logs, the

(9) 7th Annual Report (April 1951 — March 1952) p. 23.
(10) *Agric. J. Fiji* Dec. 1954, **25** no. 3 & 4, p. 87.
(11) ,, ,, ,, 1957, **28** no. 1 & 2, pp. 15-18.

author is of opinion that the procedure is fraught with the greatest danger. Instead of being traps, dead coconut trunks simply constitute infestation foci in the plantations. Scrupulous sanitation of the plantations should therefore be immediately resorted to and dead coconut trunks should be removed and burned at the earliest possible opportunity. Indeed not even a single husk should be left in the groves. Unless this be done and unless the recommendations made above be given effect to, the chances of eradication of *Oryctes rhinoceros* L. would be remote.

Biological control

Predatory beetles of the families Histeridae *Hololepta (Leionata)* and Elateridae (*Photophorus jansoni* and *Pyrophorus* spp.) could perhaps be obtained from New Zealand and Trinidad for introduction into Diego. The large carabid *Mecoderma spinifer* Broun and the huge Reduviid bug *Platymeris rhadamanthus* Gerst, which are respectively reported to attack the grub and adult beetle of *Oryctes*, could possibly help in the control of the rhinoceros beetle.

V — OTHER PROBLEMS

The vegetable garden — The island suffers from a great shortage of vegetables. Maize and sweet potato are grown on a small scale, but the former is parasitized by *Striga asiatica* O. Kuntze. and by a rust. The variety of sweet potato is not very palatable. The sphingid moth *Herse convolvuli* L., although present, is a minor pest of the plant.

Fruit trees — These are extremely scarce in Diego. At East Point, however, mango, jamalac, bread fruit, hog plum, jackfruit, bilimbi, papaw, seem to thrive well. Citrus plants apparently suffer from deficiency diseases. A few scale insects were also found. The insects could be controlled with insecticides.

Pesticides are not used against vegetable and fruit pests. In view of this, it is suggested that one of the employees of the Company should follow certain selected lectures in Pathology and Entomology at the College of Agriculture. Perhaps employees taking their leave could be given an extra 6 months for such training.

Improvement of soil — Considerable benefit should be derived from a visit to the island by a qualified soil chemist.

Flies and Mosquitoes — Owing to the high temperature and humidity, flies and mosquitoes breed in enormous numbers. The effect of countless bites from mosquitoes must be very depressing. It was noted that in addition to wells, coconuts eaten by rats and invariably containing rain water, bred legions of larvae. To check mosquitoes, disused wells should be sprayed with D. D. T. at regular intervals. Where practicable, fallen nuts should be burnt. Reduction of the fly population by the use of malathion could also be tried.

VI – SUMMARY

Nut production in the atoll of Diego Garcia is falling. This is caused by a number of factors : the groves are old and need replanting ; rats also destroy about a quarter of the crop ; but the greatest damage is caused by the rhinoceros beetle, *Oryctes rhinoceros* L., which kills about 1/3 of the seedlings being replanted. Insecticidal treatment is recommended to prevent damage to the young palms ; improved sanitation of the groves would probably reduce larval population to a very low level.

VII – ACKNOWLEDGEMENTS

The writer wishes to record his thanks to Mr. G. Lanier, the Manager of Diego Garcia and to his staff for the kindness shown to him during his stay in the island and for their assistance in supplying some of the data presented in this report. It is his pleasant duty also to tender sincere thanks to Mr. J. Lamusse, Secretary of Diego Ltd., and to Captain d'Argent of the M. V. " Sir Jules " who spared no effort to make his visit an agreeable one.

VIII – REFERENCES

Adam, J. 1942 — Les plantes à matière grasse, Vol. II — Le cocotier, etc., Paris.

Anonymous, 1952 — Recent advances in rodent control with Warfarin. Sorex (London) Ltd.

Bourne, G. C. 1888 — The atoll of Diego Garcia and the coral formations of the Indian Ocean — *Proc. R. Soc.* XL iii-449-461.

Briton-Jones. H. R. 1940 — The diseases of the coconut palm. London.

Child, R. 1950 — Recent research on the coconut palm with special reference to Ceylon. *Empire J. Exp. Agric.* 18, 177-189.

" " " — The Coconut Industry of Ceylon. *World Crops* **2** (3), 192-106.

" " 1953 — The Coconut — *New Biology* **15**, 25-42.

Cobley, L. S. — An introduction to the botany of tropical crops.

CODINE, J. 1868	Mémoire géographique sur la Mer des Indes, Paris.
COOKE, F. C. 1932	Investigations on coconuts and coconut products. Dept. Agric. Strait Setts. & Fed. Malay States. Gen. Ser (8).
„ „ 1936	The Coconut Industry of the Philippine Islands. Dept. Agric. etc., (23).
COPELAND, E. B. 1921	The Coconut — London.
D'AVEZAC, M. 1848	L'Univers pittoresque — Tome IV — 3e partie — Paris.
D'UNIENVILLE (Baron) 1829	Statistique de l'Ile Maurice.
DOTY, R. E. 1951	A promising new rodenticide for canefields. *Ha. Plant's Rec.*
DUMBLETON, L. J. 1952	Rhinoceros beetle in the Kingdom of Tonga. S. Pac, Comm. Tech. paper (34).
DUSSERCLE, R. 1934	Archipel de Chagos — Port Louis.
„ „ 1936	L'île d'Aigle — Port Louis.
GOONEWARDENA, H. F. 1958	The Rhinoceros Beetle *Oryctes rhinoceros* in Ceylon. *Trop. Agric.* CVIV No. 1.
HANNING-LEE, F. C. 1946	South Indian Ocean Pilot.
LE PELLEY, R. H. 1955	Observations on the control of insects by hand collection. *Bull. Ent. Res.* **26**, 533-541.
LEPESME, P. 1947	Les insectes des palmiers, Paris.
LIONNET, J. G. 1924	L'Ile d'Agaléga, Paris.
NUTMAN, F. J. & ROBERTS, F. M. 1955	Lethal yellowing — *Exp. Jour. Exp. Agric.* **23**, 257-267.
— do —	Frond drop. **23**, 268-271.
O'CONNOR , B. A. 1932	*Agric J. Fiji.* **24** (1-2), 35-46.
„ „ 1954	„ „ „ **25** (1-2), 17.
„ „ „	„ „ „ „ (3-4), 84-88.
„ „ 1957	„ „ „ **28** (1-2), 15-18.

PATEL, J. S. 1938	The coconut : a monograph — Madras.
SAMPSON, H. C. 1923	The Coconut Palm — London.
SIMMONDS, H. W. 1925	Bull (19) Dept. Agric. Fiji.
,, ,, 1939	Biological control of the Rhinoceros Beetle. **20,** Dept. Agric. Fiji.
,, ,, 1949	*Bull. Ent. Res.* **40,** 445.
,, ,, 1953	*Agric. . Fiji.* **24** (3 & 4).
SMITH, H. H. & PAPE, F. A. G. 1912	Coconuts — The Consols of the East. London.
TAYLOR, T. H. C. 1935	The campaign against *Aspidiotus destructor* Sign. *Bull Ent. Res.* 26 (1), 102.
,, ,, 1937	The Biological Control of an Insect in Fiji. (Imperial Institute of Entomology).
VANDERPLANK, F. L. 1958	The Assassin Bug. *Platymerus rhadamanthus* Gerst (Hemipters : Reduviidae), a useful predator of the rhinoceros beetles *Oryctes boas* (F.) and *Oryctes monoceros* (Oliv.) (Coleoptera : Scarabaeidae). *J. Ent. Soc. S. Afr.* 21, No. 2 309-314.
WIEHE, P. O. 1939	Report on a visit to the Chagos Archipelago.
WILLIAMS, J. R. 1953	Field rats on sugar estates and methods for their control. *Rev. Agric. Maur.* **32** (2) 56-66,

REVUE DES PUBLICATIONS TECHNIQUES

ANON.— **Experiments in diffusion in the cane sugar industry.** (Expériences de diffusion en sucrerie de cannes). *Aust. Sugar J.*, 50 **(9)**, 761-766.

Des essais pour extraire le sucre de la canne par le procédé de diffusion vont être entrepris sur une échelle industrielle à Hawaii où un diffuseur de 50 tonnes, mesurant 60 pieds de long a été installé à la sucrerie de la Kekaha Sugar Company. Le Dr. J. Payne et d'autres technologistes de la « Hawaiian Sugar Planters' Association » prendront une part active aux essais.

De semblables expériences ont récemment été faites en Afrique du Sud, mais sur une plus petite échelle. Un diffuser traitant 600 livres de cannes défibrées à l'heure fut utilisé. La première moitié du diffuseur était à double cloisonnement pour permettre de chauffer l'eau jusqu'à 105°C en passant de la vapeur entre les cloisons de l'appareil. La canne était préparée dans un défibreur, mais la qualité de cette préparation variait beaucoup pour des cannes de différents ligneux et au moins dix pour cent de la matière première alimentant le diffuseur consistait en des cossettes dont la dimension minimum était plus grande qu'un demi pouce. Le passage de la canne à travers le diffuseur se faisait au moyen d'une vis sans fin, dont le fonctionnement ne fut toutefois pas satisfaisant.

Le Dr. Van Der Pol de la « South African Sugar Milling Research Institute » fit les commentaires suivants sur cette expérience.

Il faut chauffer la canne défibrée à au moins 75°C pour rendre les cloisons cellulaires partiellement perméables et permettre au sucre de diffuser à travers celles-ci. A cette température les colloïdes sont précipités et l'on obtient donc par diffusion un jus plus pur que celui obtenu par le broyage de la canne dans des moulins. Pour obtenir un taux de diffusion maximum, il faut avoir la plus grande différence possible de concentration entre le jus des cellules et le liquide extracteur, généralement l'eau. Une forte température, une grande surface de contact entre les cannes défibrées et l'eau, un mouvement rapide de l'eau autour de celles-ci et une fine préparation sont autant de facteurs augmentant la diffusion. Malheureusement plus fine est la préparation, plus les cellules sont brisées, libérant ainsi des impuretés dans le jus. Il semblerait donc qu'il faille abandonner les avantages d'un jus très pur pour une meilleure extraction de sucre. L'on pourrait dans ce but utiliser des couteaux suivis d'un shredder et d'un moulin à trois cylindres qui retirerait environ 50 pour cent du jus.

SOCKILL R. D. — **Character of fibre as related to milling quality of cane.** (Caractéristiques du ligneux en relation avec les qualités de broyage de la canne). *Proc. 25th Conf.* (1958) *Queens. Soc. Sugar Cane Tech.*, pp. 53 - 58.

La structure de la tige chez différentes variétés de cannes a une influence très marquée sur le comportement de ces variétés aux moulins ainsi que sur l'humidité finale de la bagasse. Ceci est d'ailleurs très connu de ceux qui ont charge du réglage des moulins. Ces différences sont dues à des variations dans la quantité de fibre, leur résistance au broyage et leur capacité à conserver leur humidité.

Comparant les variétés Pindar, Q. 50 et Badila, l'auteur a étudié l'influence des facteurs suivants sur le travail des moulins :

a) La force sous la tension des faisceaux vasculaires individuels, leur nombre par unité de surface et leur distribution aux différents endroits de la tige.

b) La grosseur des cellules de moëlle, l'épaisseur de leurs parois et leur distribution.

c) Les quantités relatives de cellules de moëlle et de faisceaux vasculaires.

Il découle de cette étude que la qualité la plus désirable de la structure de la canne du point de vue de l'extraction des moulins est une résistance élevée à la tension des faisceaux vasculaires ; d'autres desiderata sont une teneur moyenne en ligneux et une proportion de nœuds et d'écorce pas trop grande car ceux-ci contiennent moins de sucre et sont plus difficiles à épuiser.

ALEXANDER, J. B. — **Centrifuging of mixed juice as an aid to the production of a better raw sugar.** (Turbinage du jus mélangé dans le but d'obtenir un sucre roux de meilleure qualité). *Sug. Mill. Res. Inst. Quart. Bull.* No. 7, pp. 26 - 28.

La teneur élevée en amidon des sucres du Natal étant une source de doléances de la part des raffineurs, les différentes méthodes d'élimination de l'amidon furent examinées dans le but d'en trouver une qui serait réalisable en pratique industrielle. Celle qui fut retenue fut le turbinage du jus mélangé car il avait été plusieurs fois déjà démontré dans les laboratoires de l'Institut qu'elle permet une élimination de plus de 90 pour cent de l'amidon présent dans le jus. Il fut donc décidé de faire des essais sur une échelle industrielle et un séparateur De Laval fut installé à la sucrerie de Umzimkulu. Cette sucrerie manipule environ 34 tonnes de cannes à l'heure et produisait virtuellement la quantité maximum de jus que la machine pouvait traiter. Une série d'essais dont la durée varia entre une et trois heures chaque fut donc effectuée et les résultats suivants furent obtenus :

No. du test	Amidon dans les jus mélangés	Amidon dans le jus turbiné	Amidon dans les boues	Matières insolubles totales dans les boues.
—	—	—	—	
1	220	50	9,400	—
2	415	65	12,600	9,0
3	260	55	8,400	7,7
4	215	50	—	10,7

Ces résultats font voir que le séparateur permet une élimination d'environ 80 pour cent de l'amidon contenu dans le jus. L'auteur espère entreprendre des essais plus longs durant la campagne sucrière 1958 à la sucrerie Glendale.

WALSH, E., WRIGHT, B. F., & ALEXANDER, J. B. — **The use of sucrose solution for the determination of available CaO in commercial lime.** (L'emploi de solutions de sacchorose pour le dosage du CaO dans les échantillons de chaux commerciale). *Sugar Mill. Res. Inst. Quart. Bull.* No. 9, pp. 10-11.

Le teneur en CaO de la chaux dont on se sert en sucrerie pour la clarification des jus peut être exprimée soit en CaO total soit en CaO disponible. Puisque lors de la clarification c'est le CaO disponible qui réagit, il est de coutume au laboratoire de sucrerie de doser seulement celui-ci. Dans ce but l'on se sert ordinairement d'une solution sucrée pour l'extraction.

Les auteurs ayant été avisés que des laboratoires avaient trouvé, pour le même échantillon de chaux, des teneurs en CaO disponible différentes lorsque des sucres de différentes qualités avaient été employés, une étude du problème fut décidée. Un échantillon de chaux commerciale fut donc analysé au moyen de sucres blancs et de raffinés de différentes origines ainsi que de saccharose pur. Dans certains essais des impuretés furent ajoutées au saccharose dans le but de déterminer leur influence sur le dosage. Les résultats suivants furent obtenus :

Sucre employé pour l'extraction	Impuretées ajoutées	CaO disponible
—	—	—
Sucre blanc Doorzukop	—	85,4
,, ,, Sezela	—	81,3
Raffiné Hulett	—	89,6
Raffiné, Natal Estates	—	89,1
Sucre Blanc, Entumoni	—	89,3
Saccharose C. P.	—	90,7
,, ,,	9mg SO_4Ca + 10mg SO_4K_2	90,6
,, ,,	33 mg glucose	86,9
,, ,,	33 mg fructose	81,3

Il ressort de ces essais que la qualité du sucre employé a une influence appréciable sur le dosage et que les sucres réducteurs, en particulier le fructose, diminuent la valeur de CaO disponible.

Lors d'essais subséquents entrepris avec de la chaux chimiquement pure à laquelle différentes impuretés avaient été additionnées, il fut démontré que le manganèse soluble peut causer une nette diminution de la valeur du CaO disponible. Puisque les chaux employées dans les sucreries du Natal contiennent jusqu'à 2% de O^3Mn^2, l'effet du manganèse soluble est sans doute plus important sur la teneur en CaO disponible que celui des sucres réducteurs (moins de 0,03%) du sucre raffiné dont on se sert normalement pour le dosage.

Finalement, un nombre d'échantillons furent analysés au moyen de solutions sucrées ainsi que par extraction au phénol, et les résultats suivants furent obtenus :

Échantillon de chaux	CaO % disponible	
	Méthode au phénol	Méthode au saccharose C. P.
a	85.7	84,7
b	77,7	76,9
c	95,1	94,5
d	67,5	59,0
e	81,5	72,9
f	89,6	87,7
g	91.6	89,8
a + 40 mg Cl^2Mn	85,5	81,4

Comme le font voir les chiffres ci-dessus, la méthode d'extraction au moyen de solutions sucrées indique toujours des teneurs de CaO disponible plus faibles que celles obtenues par la méthode au phénol, en particulier en présence de sels solubles de manganèse et de sucres réducteurs.

Les auteurs concluent que l'emploi de solutions sucrées n'est pas recommandable pour les dosages de CaO disponible, particulièrement en présence de sucres réducteurs et de sels solubles de manganèse. La méthode d'extraction au phénol est par contre exempte de tels désavantages.

PERK, Chs. G. M. — **The detection of traces of sugar in condenser water and condensates.** (La détection de traces de sucre dans l'eau du condenseur et les eaux condensées). *Sugar Mill. Res. Inst. Quart. Bull.* No. 6, p. 19.

Il existe plusieurs méthodes pour détecter des traces de sucre dans les eaux. La plus couramment employée est connue sous le nom de réaction annulaire, et se fait au moyen d'une solution alcoolique d'alpha-napthol à 10-20 pour cent et d'acide sulfurique concentré. La Société de Technologistes du Sucre de l'Afrique du Sud (S.A.S.T.A.) recommande

la méthode de Matthews. L'avantage de cette méthode git dans le fait qu'elle se sert d'étalons permanents qui permettent un dosage quantitatif du sucre. Elle n'est toutefois pas aussi sensible que la réaction annulaire à l'alpha-napthol, et est plus compliquée et plus longue que celle-çi.

Par contre une méthode plus sensible, moins longue et moins délicate que la réaction annulaire est celle dite de Skarblom. Les réactifs employés dans les deux méthodes sont les mêmes, sauf que dans le cas du test Skarblom l'on se sert d'une solution alcoolique d'alpha-napthol à 4 pour cent (tube à essais 80mm de long et 10mm de diamètre) est rempli avec l'eau que l'on veut examiner. Le tube est tourné sens dessus-dessous pendant deux secondes pour le dévider, puis ramené à la position verticale, ce qui permet à une goutte d'eau d'environ 0.2 c.c. d'être récoltée au fond du tube. Cette goutte représente le volume nécessaire pour le test.

L'on ajoute alors au tube 1-2 gouttes d'une solution alcoolique d'alpha-napthol à 4 pour cent, puis 15-20 gouttes d'acide sulfurique concentré. L'on secoue bien le tube pour mélanger les liquides, et si la solution devient violette en moins de 30 secondes l'on sait que l'échantillon contient du sucre.

BERTRAND. D. — **Importance trop souvent méconnue du problème des oligo-éléments**. *Technique Agricole* — 132, 35-37, 1958.

Par définition le terme oligo-élément ainsi que la racine grecque l'indique veut dire élément dont il y a peu. Ainsi le sang des vertébrés contient du fer sous forme d'oligo-élément puisque ce métal s'y trouve en proportion de 50 milligrammes au kilo. Il n'y est pas remplaçable par un autre élément et joue un rôle important dans la synthèse de l'hémoglobine; mais il y a plus encore, cette hémoglobine ne peut être synthétisée qu'en présence de cobalt, un autre oligo-élément encore plus spécifique et dont la teneur dans le sang est environ 10,000 fois plus faible que le fer. Sans le cobalt les animaux carencés dépérissent et meurent. Le rôle des oligo-éléments intervient encore dans les systèmes enzymatiques, soit comme co-enzymes soit comme étant nécessaires à la synthèse même des enzymes.

L'auteur donne une liste de 25 oligo-éléments affectant l'état sanitaire des cultures et des élevages.

Il est nécessaire de déterminer si les besoins des végétaux et des animaux en ces éléments sont satisfaits. C'est là un point d'autant plus important que les cultures et élevages sont menées de façon plus intensive.

L'aspect des plantes ou des animaux souffrant de carence ne présente pas toujours un caractère spécifique permettant de déceler la déficience à l'exception pourtant de la "rosette" des arbres fruitiers provoquée par un manque de zinc et du goitre thyroïdien provoqué par une carence en iode. L'étude du comportement des plantes vis-à-vis des carences aurait

pu permettre un diagnostic des différentes carences ; malheureusement les besoins des divers végétaux ne sont pas les mêmes et les renseignements ainsi obtenus pourraient conduire à des erreurs de diagnostic. L'analyse du sol peut quelque fois servir d'indication de carence des minéraux dans le milieu nutritif. L'analyse des végétaux peut encore utilement compléter ces renseignements, mais pour bien interpréter ces résultats analytiques il faut connaître les taux normaux très variables de chaque espèce de plante, de son âge et de l'organe analysé.

D'une façon générale l'effet de l'oligo-élément est d'autant plus grand que sa quantité croît. Mais au-delà d'une certaine valeur il y a décroissance par suite d'une action toxique qui se superpose à l'action utile. Il existe donc une teneur optimale pour laquelle l'effet est maximum, mais encore l'optimum de concentration nutritive dépend de l'effet recherché et varie avec les espèces. Ainsi il faut plus de cuivre pour obtenir une bonne toison du mouton que pour obtenir le maximum du poids de chair ; il faut beaucoup plus de molybdène pour les légumineuses que pour les graminées, les premières pouvant se trouver carencées dans des terrains où le blé ne le serait pas, et enfin les légumineuses exigeant d'autant plus de molybdène que le terrain est plus aride.

Dans certains cas la toxicité de l'élément déficient est très marquée pour des concentrations ne dépassant que de très peu celle correspondant à l'optimum. Dans d'autres cas pourtant, les teneurs au-dessus de la concentration optimale peuvent ne pas être toxiques. Il est maintenant facile de comprendre la raison des échecs de nombreuses expérimentations et de l'importance d'une étude plus précise sur le rôle des oligo-éléments chez les végetaux et les animaux ainsi que les exigences particulières des différentes espèces dans des conditions d'élevage ou de culture variables.

DETILLEUX, — **La culture de la patate douce dans la région d'Elizabethville.** *Bull. Inf. de l'INEAC* — VII, 4, 237-260, 1958.

Dans la région d'Elizabethville, la culture de la patate douce est particulièrement indiquée en raison des avantages qu'elle présente.

Les racines par leur teneur intéressante en hydrate de carbone, protéines et en graisse constituent une réserve utile pour l'alimentation des centres extra-coutumiers. En saison sèche elles conviennent également bien pour l'alimentation des bovins et des porcs ; elles interviennent dans l'établissement de la ration fourragère de base du betail laitier de la mi-juin à la fin de novembre, soit durant cinq mois et demi.

Les tiges et feuilles représentent, elles-aussi, une réserve appréciable pour les éleveurs de la région. Elles constituent de mi-mars à mi-juin l'unique ressource fourragère verte disponible et distribuée à raison de 30 kg par jour. De plus, la patate et la pomme de terre sont les seules plantes dont la culture est indiquée en tête de rotation après défrichement.

A la suite des essais de culture avec fumure organo-minérale qui ont été entrepris, l'auteur arrive aux conclusions générales suivantes :

1) la fumure organo-minérale augmente la production en feuillage, tout en maintenant le prix de revient de ce dernier à un niveau inférieur à celui obtenu en culture non-fumée ;

2) la superficie plantée peut être réduite de 30 à 50% d'où :

— économie de main-d'œuvre ;

— meilleure utilisation du terrain et réduction de transport due à une plus grande concentration ;

— possibilité de surveillance plus efficace, (risques de vol moins élevés).

3) l'arrière effet de la fumure sur la culture de maïs pratiquée la saison suivante permet de réduire les apports de sels minéraux à une seule dose de 200 kg/ha de nitrate d'ammoniaque. D'ordinaire, les quantités à appliquer s'établissent comme suit : 500 kgs nitrate d'ammoniaque, 200 kg superphosphate et 50 kgs de sulphate de potasse à l'hectare. Il en résulte donc une diminution sensible du prix de revient de l'unité fourragère du maïs.

NICLAES, J. & DEMOL, J. — **La floraison de l'arachide dans les conditions climatiques de Bambesa**. *Bull. Agric. Congo Belge.* VII, 6, 1501 — 1511, 1958.

Dans les conditions climatiques de Bambesa et pour une variété hâtive d'arachide à type érigé la floraison se déclenche très régulièrement environ 25 jours après le semis. La floraison comprend quatre phases :

1) déclenchement de la floraison jusqu'à son maximum (9 jours) ;
2) régression du nombre de fleurs par plant jusqu'au palier de floraison (5 jours) ;
3) palier de floraison (12 jours) ;
4) chute de floraison (à partir du 49e jour après le semis).

En dessous de 31°C., une augmentation globale de la floraison est dictée par un relèvement de la température de l'air pendant la période couvrant les 10 jours précédant et les 20 jours suivant le début de la floraison. Un arrêt complet de l'éclairement pendant une journée provoque, dans un délai de 3 jours, un arrêt de la floraison. Une floraison abondante ne se produit chez l'arachide que 3 jours après une journée présentant une température d'au moins 28°C. et une durée minimum d'insolation de 4 heures.

Ces deux dernières observations semblent indiquer l'existence d'un photopériodisme et d'un thermopériodisme comme facteurs déterminant la floraison de l'arachide.

WHITESIDE, Dr. J. O. — **Experiments in controlling diseases of tomatoes in Southern Rhodesia.** (Expériences sur la lutte des maladies de la tomate). *Rhodesia Agric. J.* 55, 5, 533-545, 1958.

En Rhodésie du Sud la septoriose de la tomate était la principale maladie s'attaquant à cette culture, mais en 1956 le mildiou occasionné par *Phytophthora infestans* fit son apparition et provoqua de très lourdes pertes chez les cultivateurs de tomates. L'auteur entreprît une série d'expériences sur le traitement des maladies cryptogamiques de la tomate à l'aide des fongicides chimiques suivants : bouillie bordelaise, blitox, dithane Z-78, dithane M-22, captan, zineb, maneb et oxychlorure de cuivre. Les résultats de ces expériences sont :

La septoriose de la tomate est contrôlée avec efficacité par l'oxychlorure de cuivre, le zineb et le maneb. Le captan s'est montré moins efficace. C'est la bouillie bordelaise qui fut le traitement le plus efficace, mais ce fongicide occasionne d'importants dommages aux feuilles et aux fruits.

Dans le contrôle du mildiou, le maneb a toujours donné les meilleurs résultats. Dans l'ordre d'efficacité vient ensuite le mélange captan-zineb (1 lb : 1 lb ; 100 gallons) bien supérieur à chacun de ces deux fongicides employés séparément à la dose de 2 lb 200 gallons, le captan se montrant cependant supérieur au zineb.

L'époque et la séquence d'application des traitements sont d'importance particulière. Si l'application est en retard et se fait après la parution du mildiou, le fongicide contrôlera difficilement la maladie. Il faut donc employer le fongicide préventivement. Il est nécessaire que les plants traités aient toujours un film protecteur du fongicide sur leurs tiges et leurs feuillages. Dans la saison pluvieuse il faut refaire les pulvérisations à chaque fois que la chute des pluies aura atteint 2 pouces et au moins une fois chaque semaine. Il faudra donc environ 8 à 12 pulvérisations pour assurer la protection d'une culture.

L'attention des fermiers est attirée sur la nécessité de protéger les jeunes pousses qui sont généralement plus susceptibles ainsi que les semis trop denses.

STATISTIQUES DES CONDITIONS MÉTÉOROLOGIQUES

MARS - AVRIL 1959

A. Pluie par région: (a) quantité en pouces, (b) différence de la normale

Période		Ouest		Nord		Est		Sud		Centre	
		a	b	a	b	a	b	a	b	a	b
Mars	1 — 15	7.60	+3.18	5.03	+0.68	9.57	+2.73	9.98	+3.63	10.48	+3.64
„	16 — 31	4.44	+0.04	2.90	+1.53	5.70	—1.45	5.21	—1.32	7.61	+0.92
Avril	1 — 15	1.08	—1.64	2.20	—1.39	3.08	—2.93	2.94	—2.90	2.91	—2.36
„	16 — 30	0.13	—1.81	0.90	—2.11	2.53	—2.71	2.88	—2.44	2.23	—2.08

B. Température — (a) moyenne (b) différence de la normale

Période		Pamplemousses				Plaisance				Vacoas			
		Max. °C		Min. °C		Max. °C		Min. °C		Max. °C		Min. °C	
		a	b	a	b	a	b	a	b	a	b	a	b
Mars	1 — 15	30.1	—0.4	22.0	+0.3	29.2	—0.6	22.7	+1.1	26.8	—0.3	21.1	+0.4
„	16 — 31	29.8	—0.4	22.9	+1.6	28.9	—0.4	23.8	+2.2	26.4	—0.4	21.6	+1.3
Avril	1 — 15	30.1	+0.4	20.0	—0.7	28.7	0.0	21.5	+0.1	26.7	+0.7	19.3	—1.2
„	16 — 30	28.5	—0.5	18.1	—1.8	26.7	—1.3	21.1	0.0	24.3	—0.8	17.8	—1.6

C. Température — différence de la normale de la température moyenne de l'île.

Période		Max. °C	Min. °C
Mars	1 — 15	—0.4	+0.6
„	16 — 31	—0.4	+1.7
Avril	1 — 15	+0.4	—0.6
„	16 — 30	—0.9	—1.1

Vélocité du vent en nœuds.*

Période		Pamplemousses		Plaisance		Vacoas	
		Moyenne quotidienne des vélocités horaires les plus élevées	Vélocité horaire la plus élevée	Moyenne quotidienne des vélocités horaires les plus élevées	Vélocité horaire la plus élevée	Moyenne quotidienne des vélocités horaires les plus élevées	Vélocité horaire la plus élevée
Mars	1 — 15	—	—	12	18	10	23
„	16 — 31	—	—	15	17	12	16
Avril	1 — 15	8	17	8	13	9	15
„	16 — 30	10	15	9	14	10	13

*Pour convertir en milles à l'heure multiplier par 1,151.

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(E)

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(A) *Below :* Cleaning Evaporator Tubes with a Twin Drive Machine at a Sugar Refinery.

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(B) *Below :* Removing Scale from Babcock & Wilcox Boilers in an Indian Refinery.

(C) *Below :* Cleaning the tubes of horizontal Juice Heating Plant in an Indian Sugar Factory.

(D) 'Skatoskalo' Electric, Petrol-Driven and Pneumatic Machines, rotary Scaling tools, wire brushes etc., are designed to do routine cleaning and descaling work quickly, positively and thoroughly.

(E) *Left :* Operating two machines simultaneously of the cleaning of an evaporator.

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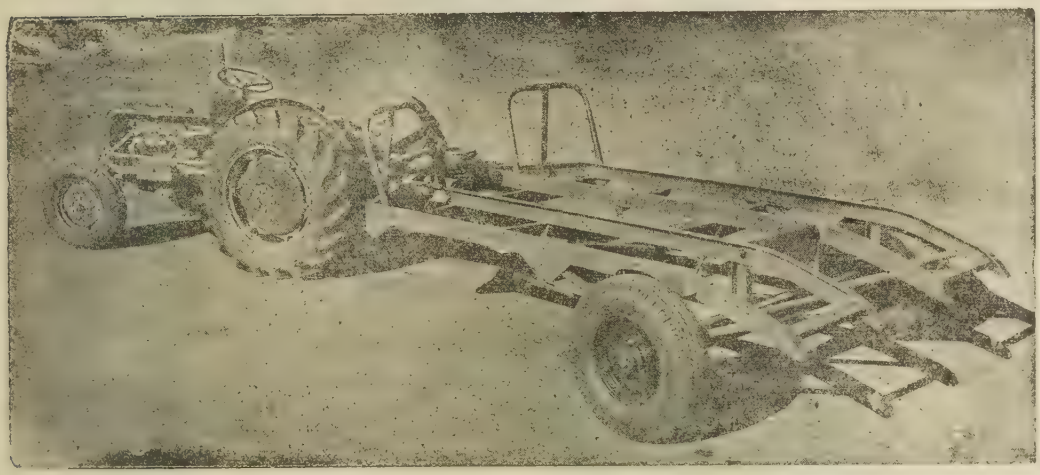

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Pour un MATELAS

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EXIGEZ LE VERITABLE

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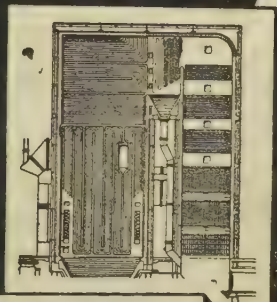
Spitzenleistungen seit 20 Jahren

B W

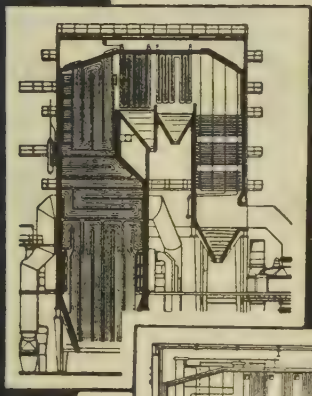
1938



100 t/h 500° C

160 atü

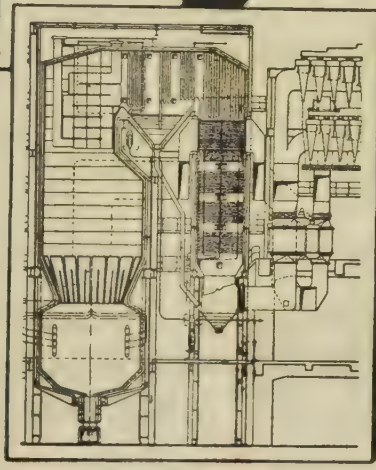
mit Strahlungs-Zwischen-Überhitzer



128 atü 530° C

300 t/h

1954



300 t/h 176 atü

610°C

MASCHINENFABRIK BUCHAN R. WOLF
GREVENBROICH — GERMANY

Agents:
DYNAMOTORS Ltd.
PORT LOUIS

263,453 miles

without engine overhaul!

and this is the 7 tonner that did it!

Owned by Messrs. J. Kime & Son, Haulage Contractors of Lincoln,

it has completed 263,453 miles without requiring an engine overhaul. On dismantling, the cylinder bore wear was found to be only one-and-a-half-thousandths of an inch. "This vehicle", the owners write, "in almost continuous use for the past six years, is still in 100% condition. In the whole of our thirty years experience we have never been so confident in the ability of our lorries"

. . and it is only one of many

All over the world Commer 'under-floor' engines, with full-length porous chrome bores, are giving phenomenal mileages between overhauls and achieving sensational reductions in maintenance costs.

COMMER

5-12 TONNERS
WITH PHENOMENAL LIFE
POROUS CHROME BORE ENGINE

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1, Queen Street,
Port Louis.
Sales Representatives

...HE FACED RUIN

HE SMILED...

when he saw his CAT* Diesel powered machines working faithfully, keeping ahead of schedule.

HE SHRUGGED...

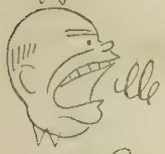
when he learned that some of the older machines would require replacement parts after many seasons of use.

STILL CHEERFUL...

he searched for "bargain" spares and found them. They looked just as good as genuine parts.

HE HELD HIS BREATH...

when some of the spurious spares had to be hammered, filed and coaxed into place.



HE EXHALED...

a searing blast when the substitute spares began to fail and rendered several of his machines idle.

HOPEFULLY...

he came to us. We replaced the misfits with Genuine Caterpillar Parts and put the machines in good working order.

NOW...

his smile is greater than ever. His machines are again working faithfully and economically. He knows how to keep them working!

CATERPILLAR*

*Both Cat and Caterpillar are registered trade marks

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The Caterpillar Tractor Co.

The Mauritius Commercial Bank Ltd.

Incorporée par Charte Royale, en 1838, et enregistrée comme Compagnie à responsabilité limitée le 18 Août 1955.

Capital : Rs. 3,000,000.—

Réserves : Rs. 4,070,110.09

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Agents à Londres : LLOYDS BANK LTD.
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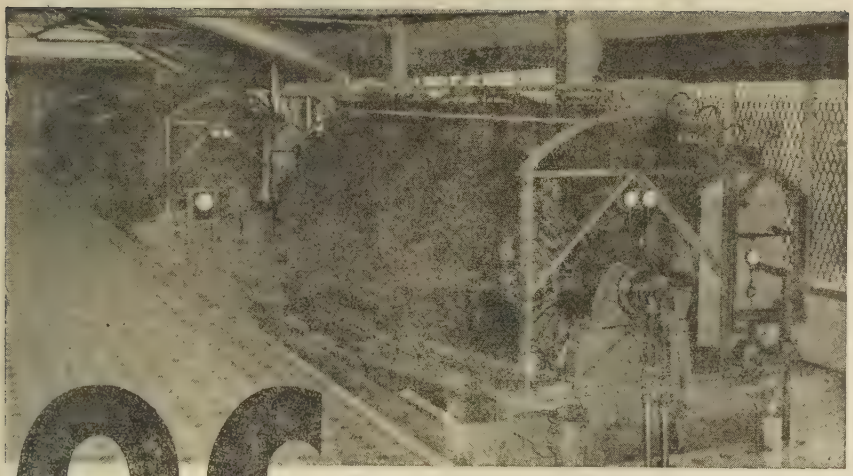
Toutes opérations de Banques



O C

***Initials Well Known Throughout the World's Cane Sugar Industry**

***Initials that are your Assurance of a Cane Mud Filter *Proved* by over 700 Operating Units**

Initials on equipment have come to be recognized all over the world as an insignia of approval . . . of integrity . . . of service. It's just as if the equipment is stamped "OK". The O-C on our cane mud filter is no exception.

Unless it produces the results expected, no piece of equipment — certainly none in the capital investment class — can establish a record of over 700 units installed and operating throughout the cane sugar world. This is exactly what the Oliver Campbell Cane Mud Filter has done. The O-C has proved conclusively that it provides the most efficient, lowest cost handling of cane muds . . . that it requires very little maintenance . . . and that structurally, it is built to operate for years and years.

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CHLORATE DE SOUDE — 99/100% de pureté.

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SUPER KNAPSACK

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Compresseurs pour remplir les appareils.

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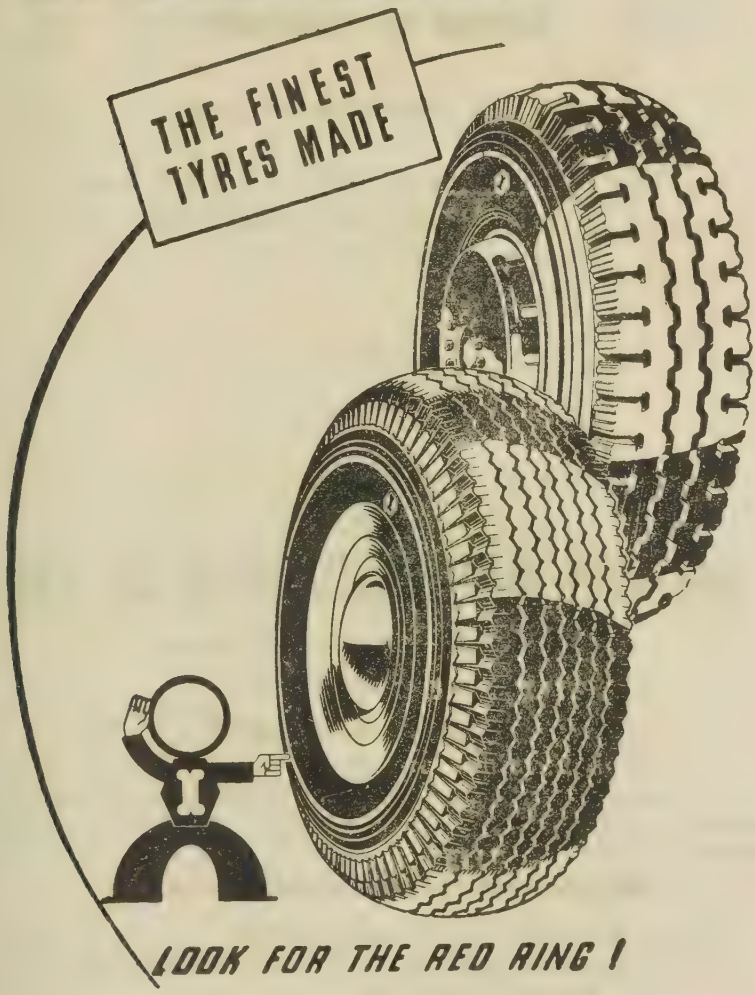

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